JRC Scientific and Technical Reports

Towards a set of composite indicators on Flexicurity: the Indicator on Flexible and Reliable Contractual Arrangement

Anna Rita Manca, Matteo Governatori and Massimiliano Mascherini

EUR 24330 EN - 2010

JRC EUROPEAN COMMISSION

ipsc Institute for the Protection and Security of the Citizen

The mission of the JRC-IPSC is to provide research results and to support EU policy-makers in their effort towards global security and towards protection of European citizens from accidents, deliberate attacks, fraud and illegal actions against EU policies.

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

Contact information
Anna Rita Manca
European Commission- Joint Research Centre
Address: Via Enrico Fermi 2749, Ispra, Italy
E-mail: Anna.Manca@jrc.ec.europa.eu
Tel.: +39(0)332789314
Fax: +39(0)332785733
http://ipsc.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/

Matteo Governatori
Directorate General for Employment, Social Affairs and Equal Opportunities
Employment Analysis
Address: Rue Joseph II 27, 1049 Brussels, Belgium
E-Mail: Matteo.Governatori@ec.europa.eu
Tel.: +32(0)22993436
Fax: +32(0)22994233

Massimiliano Mascherini
European Foundation for the Improvement of the Living and Working Condition
Address: Wyattville Road Loughlinstown, Dublin 18, Ireland
E-Mail: Massimiliano.Mascherini@ eurofound.europa.eu
Tel.:+35312043108
Fax.:+35312826456

JRC 58076

EUR 24330 EN
ISBN 978-92-79-15592-5
ISSN 1018-5593
DOI 10.2788/84920

Luxembourg: Publication Office of the European Union

Printed in Italy

Contents

1 Introduction

This paper presents a composite indicator to measure the flexible and reliable contractual arrangements (FCA) dimension of flexicurity, using 19 indicators based on different sources such as Eurostat's Labour Force Survey, the OECD indicator on Employment Protection Legislation (EPL) and the Compendium for the monitoring and analysis of Member States' progress towards the objectives set by the Employment Guidelines, adopted by the EU Employment Committee (EMCO).

Together with the composite indexes on Life Long Learning (LLL), Active Labour Market Policies (AMLP) and Modern Social Security System (MSS) previously elaborated, this exercise is part of a joint project of DG Employment and the Joint Research Centre[1] aimed to measure the level of Flexicurity across the EU through a set of four composite indicators corresponding to the four main dimensions of the concept identified by the European Commission[2]. Such indicators are described in separate reports produced within the project. This exercise should be seen as complementary to the analysis of flexicurity in the EU carried out by Commission services within the *Employment in Europe* reports of 2006 and 2007 (see European Commission, 2006 and 2007).

The FCA index is computed following the methodology developed in the OECD/JRC handbook on composite indicators. The paper is organized as follows. Section 2 lists the indicators included and presents their characteristics and problems. Section 3 presents the methodology adopted for computation of a composite indicator. Section 4 shows the results. Section 5 carries out uncertainty analysis of their robustness. Finally, section 6 presents results on a country-by-country basis.

2. The list of Indicators

The list of basic indicators included in the index follows the theoretical framework jointly developed by DG EMPL/D1 (Employment Analysis unit) and JRC/G09.

A set of 19 indicators have been selected from different sources including, mainly, the Compendium of indicators developed by the Employment Committee (EMCO) to monitor Member States' progress towards the objectives set in the Employment Guidelines (hereinafter the Compendium), the Labour Force Survey Database of Eurostat and the OECD's EPL database.

[1] "*Statistical analysis in support of Flexicurity policy*", Administrative Arrangements 30566-2007-03 A1CO ISP BE.

[2] 1) flexible and reliable contractual arrangements; 2) comprehensive lifelong learning strategies; 3) effective active labour market policies; 4) modern, adequate and sustainable social protection systems. See COM(2007)359 of 27 June 2007 and Presidency conclusions, EPSCO Council 5/6 December 2007.

The Flexible and reliable Contractual Arrangement (FCA) index covers three dimensions, each of them including a number of indicators (which varies across dimensions). Dimensions and indicators, together with their socio-economic rationale and the sign (plus or minus) of their contribution to the composite index, are described in this section's remainder

2.1. Regulations on dismissals and use of flexible contractual forms - external flexibility.

This dimension includes six indicators:

1. Three indicators concern the Strictness of Employment Protection Legislation (EPL). These are EPL on regular (i.e. open-ended) contracts, the ratio of strictness of EPL on temporary contracts over regular contracts, and the strictness of EPL on collective dismissals[3]. Taken together, the indicators on regular contracts, temporary contracts and collective dismissals compose the well-known OECD index of overall strictness of EPL, which goes from 0 to 6, with higher scores indicating more rigid rules (OECD, 2004; Venn, 2009).

   However, in this analysis the EPL components are taken separately in order to simultaneously capture two elements: first, the rigidity of contractual rules, i.e. to what extent they facilitate/hinder the adjustment of employment levels to shocks; and second, whether their articulation encourages the creation of a dual labour market whereby firms aim at circumventing overly rigid dismissals rules on regular contracts by hiring via (more flexible) temporary contracts. Dual or segmented labour markets run against flexicurity principles, as workers under temporary contracts may face great difficulties in moving to regular ones.

   The rigidity of rules is captured by the two indicators of EPL on regular contracts and on collective dismissals; hence they both contribute with a negative sign to the composite index. Policy-driven segmentation is captured by the relative rigidity of temporary versus regular contracts (i.e. the ratio between respective EPL scores for the same country/year), which contributes positively to the composite index, as stricter regulations on the use of temporary contracts relative to hiring/dismissals rules on regular ones reduce firms' incentives to hire under temporary contracts as a way to increase employment flexibility 'at the margin' resulting in higher labour market segmentation.

2. Share of employees with fixed-term contracts. This includes two indicators, i.e. the total share and the share of involuntary fixed-term contracts[4]. The former indicator has a positive sign, as fixed-term contracts can act as gateways towards employment for disadvantaged groups (e.g. young labour market entrants or women) without necessarily leading to dual labour markets as long as transition to

[3] The source is the OECD's EPL database, complemented by Cazes and Nesporova (2007) and Tonin (2006) for Lithuania and Bulgaria.

[4] I.e. employees declaring they have a fixed-term contract because they could not find a permanent job.

better jobs and regular contracts is not hindered. On the other hand, the second indicator has a negative sign as a high share of involuntary temporary employment highlights reduced chances of moving to a regular contract which in turn is a sign of labour market segmentation. The source of these indicators is the EMCO Compendium (indicator 21.M.2).

3. The share of self-employment over total employment. This indicator has a positive sign as self-employment can be a source of labour market flexibility insofar it is not covered by specific regulations. Source: EMCO Compendium (Indicator 21.M.2).

2.2. Flexibility of working time - internal flexibility.

Flexibility is not exclusively achieved by adjusting employment levels but also the number of hours worked per worker and the type of work organisation. The latter two strategies can be referred to as internal flexibility as they are undertaken within the firm without changing the number of workers employed. This is captured by the second dimension of the composite index.

Unfortunately, qualitative features of work organisation, such as the extent of workers' autonomy and participation to firm's decisions, team work and tasks rotation could not be included, as relevant indicators are not covered in the main questionnaire of the EU LFS and other institutional data sources at the EU level. The European Foundation for the Improvement of Living and Working Conditions runs a number of EU-level surveys including such indicators. However these are undertaken only every five years and are based on small-scale national samples. As this exercise aims at constructing a statistical tool which can potentially be used for regular (i.e. yearly) policy monitoring, these variables have not been included.

Hence, this dimension only covers working time flexibility, looking at several different forms the latter can take. Five (groups of) indicators are included.

1. Variability of working time. This is measured by the coefficient of variation[5] of actual working hours, as a way to capture the overall magnitude of adjustment of working hours to changing circumstances, be they related to economic conditions (product demand, business cycles, competitiveness or technology shocks etc.) or varying workers' preferences with respect to their work-life balance. The sign is positive as greater working hours variability should contribute to higher internal flexibility overall. The source is the LFS.

2. Atypical work. This is measured by five indicators which altogether count as a single variable[6]: the share of workers doing i) shift work, ii) evening work, iii) night work, iv) Saturday work and v) Sunday work. The sign is positive in all five cases. The source is the LFS.

[5] I.e. standard deviation divided by the mean.

[6] I.e. within the internal flexibility dimension, their weights (in the construction of the index) sum up to one (equal to the weight given, for instance, to working hours' variability alone).

3. Part-time. This includes two indicators: the total share of employees in part-time and the share of those who work part-time because they could not find a full-time job. Similarly to the treatment of fixed-term employment (see 2.1. above) the sign is positive for the former and negative for the latter, as part-time in general is considered as a source of working time flexibility, whereas when it is exclusively due to lack of full-time job opportunities can be interpreted as a sign of labour markets' inefficiencies. The source is in both cases the EMCO Compendium (indicator 21.M.2).

4. Overtime. This is measured by the share of employees for whom overtime is the main reason for actual hours worked being different from usual hours worked. As overtime can be a tool for adjustment to increasing products' demand, the sign attributed to this indicator is positive. The source is the EMCO Compendium (indicator 21.A.3).

5. Access to variable working hours. This is measured by the share of employees for whom variable hours is the main reason for actual hours worked being different from usual hours worked. This is considered as a proxy to the availability of flexible working time arrangements[7] and so it contributes with a positive sign to the composite index. The source is the LFS.

2.3. Flexibility of work organisation to help combine work and family responsibilities

According to the main EU policy documents (COM(2007)359) and relevant literature (see e.g. the flexicurity 'matrix' in Wilthagen and Tros, 2004 and Wilthagen et al., 2003) flexicurity also encompasses the possibility for workers to reconcile professional and family and other private responsibilities (i.e. work-life balance). In the 2007 Communication, however, this aspect is mentioned within the modern social security component[8]. This has been reflected, in this project, in the inclusion of child-care indicators within the composite index of that dimension. However, as work-life balance is also clearly affected by the flexibility of working time and work organisation, it appeared natural to include a third dimension within the composite indicator on flexibility to capture this aspect. Three indicators are included:

1. The share of workers who have left last job/business for looking after children, other personal or family responsibilities and education or training. This indicator enters with a negative sign, as working time should in principle be sufficiently flexible to accommodate workers' private obligations and needs for further training without forcing them to leave their job. The source is the LFS.

2. Employment impact of parenthood. This is measured by the percentage difference in female employment rates[9] without and with presence of a child. The sign is

[7] A better measure would be the access to flexitime, i.e. having other working time arrangements than fixed start and end of working days. Unfortunately this measure is not included in the main LFS but only in a LFS ad-hoc module run in 2004 and not repeated in the following years.

[8] Similarly, Wilthagen and Tros (2004) speak of "combination security".

[9] The Compendium also includes the same measure for men. However, the latter is mostly negative possibly pointing to a certain resilience of the male breadwinner model and related gender stereotypes, whereby presence of a child *increases* work incentives for men while reducing it for women as the latter

again negative as a large gap signals insufficient room for reconciling work and child-care. The source is the EMCO Compendium (indicator 18.a.5).

3. Inactivity and part-time work due to lack of suitable care services for children. Following the same logic as for the previous two indicators, the sign is negative. The source is the EMCO Compendium (for the period 2006-2008, indicator 18.A.6) and the 2005 LFS ad-hoc module on work and family life.

3. Data quality and calculation methodology

The quality of data and the geographical coverage of the selected indicators are very satisfactory, overall, as the number of missing values is quite small. The different aspects of data quality have been assessed through commonly used statistical criteria. Each aspect has been evaluated from a maximum (++) to a minimum (--), following standards adopted in the LIME project[10]. Table 1 reports the full list of indicators used for the calculation of the Composite Index by dimension.

Time coverage: the index covers the period from 2005 to 2008. Using the LIME statistical standards, such time coverage can be rated with a "++".

Geographical coverage: the index covers 23 member states over the whole period considered (from 2005 to 2008), leading to a "++" rating following the LIME standards. Four Member States are excluded (i.e. Romania, Latvia, Cyprus and Malta), as EPL indicators are completely lacking for those countries. However, results for those Member States excluding EPL are shown in annex.

tend to take up much more often child care responsibilities. Given its (in most cases) negative sign, the indicator for men has not been included.

[10] Lisbon Assessment Methodology.

Table 1 - List of indicators part of Flexible and Reliable Contractual Arrangement Composite Indicator

Indicators and dimensions	*Label*	*Source*	*Availability*
Regulations on dismissals and use of flexible contractual forms (external flexibility)			
Total employees in fixed-term only contracts as % of persons in employment	totemplfix	Compendium	2005-2008
Share of employees with fixed-term contracts because they could not find a permanent job	fixnotjob	Compendium	2005-2008
Share of self-employment in total employment	shaempl	Compendium	2005-2008
Strictness of rules on regular contract	EPR	OECD 'EPL	2005-2008
Ratio of strictness of rule on temporary contracts vs regular ones'	EPT/EPR	OECD 'EPL	2005-2008
Strictness of rules on collective dismissals	EPC	OECD 'EPL	2005-2008
Flexibility of working time -internal flexibility			
Share of employees in part-time	shpartime	Eurostat	2005-2008
Share of employees in part-time because they could not find full-time job	partimejob	Eurostat	2005-2008
Overtime work : Share of employees for whom overtime is main reason for actual hours worked being different from usual hours worked	overtime	LFS	2005-2008
Numbers of hours actually worked during the reference week (Coefficient of variation)	hwactual	LFS	2005-2008
Share of workers doing evening work	evenwk	LFS	2005-2008
Share of workers doing night work	nightwk	LFS	2005-2008
Share of workers doing saturday work	satwk	LFS	2005-2008
Share of workers doing Sunday work	sunwk	LFS	2005-2008
Share of workers doing shift work	shiftwk	LFS	2005-2008
Variable working hours: share of employees for whom variable hours is the main reason for actual hours worked being different from usual hours worked	hourreas	LFS	2005-2008
Flexibility of work organization to help combine work and family responsibility			
Inactivity and part-time work due to lack of suitable care services for children and other dependants	lack of care/nowecar	LFS/Compendium	2005-2008
Employment impact of parenthood	parenthood women	Compendium	2004-2007
Share of workers who have left last job/business for looking after children, other personal or family responsibilities and education or training	leavreas	LFS	2004-2008

Missing data: the FCA index covering the period from 2005 to 2008 is based on 19 indicators. This does not necessarily mean that data for all of them are actually available for all EU Member States and all years considered. Table 2 below presents the number of indicators with available data by country and year. The situation is good overall as only a few member states present data limitations. The presence of missing data in some countries has been dealt with imputation techniques (see below).

Table 2 - Available data over the total number of basic indicators, by country

	2005	2006	2007	2008
AT	(18/19)	(19/19)	(19/19)	(18/19)
BE	(19/19)	(19/19)	(19/19)	(18/19)
BG	(11/19)	(16/19)	(16/19)	(15/19)
CY	(16/19)	(16/19)	(16/19)	(15/19)
CZ	(19/19)	(19/19)	(19/19)	(18/19)
DE	(19/19)	(19/19)	(19/19)	(18/19)
DK	(19/19)	(18/19)	(19/19)	(18/19)
EE	(19/19)	(18/19)	(18/19)	(17/19)
ES	(18/19)	(19/19)	(19/19)	(18/19)
FI	(12/19)	(19/19)	(19/19)	(18/19)
FR	(19/19)	(18/19)	(19/19)	(18/19)
GR	(19/19)	(19/19)	(19/19)	(18/19)
HU	(19/19)	(19/19)	(19/19)	(18/19)
IE	(19/19)	(14/19)	(12/19)	(17/19)
IT	(19/19)	(19/19)	(19/19)	(18/19)
LT	(16/19)	(16/19)	(16/19)	(15/19)
LU	(16/19)	(16/19)	(16/19)	(18/19)
LV	(16/19)	(16/19)	(16/19)	(15/19)
MT	(15/19)	(15/19)	(15/19)	(13/19)
NL	(16/19)	(19/19)	(19/19)	(18/19)
PL	(19/19)	(19/19)	(19/19)	(18/19)
PT	(18/19)	(18/19)	(18/19)	(17/19)
RO	(16/19)	(15/19)	(16/19)	(15/19)
SE	(18/19)	(18/19)	(18/19)	(18/19)
SI	(19/19)	(19/19)	(19/19)	(18/19)
SK	(18/19)	(19/19)	(19/19)	(18/19)
UK	(19/19)	(18/19)	(18/19)	(11/19)

The contribution of individual indicators to a composite index can have either a positive or a negative sign, according to the interpretation given to the variable that the indicator represents (see section 2 above). In other words, for every indicator 'more' can be considered to be either 'good' or 'bad'. Contrary to the CI calculated for Active Labour Market Policies and for Life Long Learning, where all components entered with a positive sign, different indicators enter with opposite sign within the FCA index.

More in detail, the **direction** has been assumed to be positive (i.e. a higher score leading to a better performance of the country) for the following indicators: ratio of EPL on temporary versus regular contracts, Share of employees with fixed-term contracts, Share of self-employment in total employment, the coefficient of variation of hours actually worked, atypical work, Share of employees in part-time, overtime and share of employees with variable hours. All remaining indicators have been given negative sign.

Correlations among indicators are also an important issue within the construction of a composite indicator. Although the identification and removal of redundant indicators is

still a controversial topic among researchers, correlation analysis remains a useful tool to that purpose. However, as highlighted in the literature, the mechanical application of correlation analysis is not sufficient to identify redundant indicators. Within a pair of indicators, one of them can be considered redundant when it is both highly correlated *and* with a similar meaning to the other.

Table 4 presents the correlation matrix for 2005. One example of pair correlations is discussed below in order to illustrate the reasoning applied. A high positive correlation is recorded between *totemplfix* and *fixjob* (see table 1 above for labels of all indicators). This implies that the higher the share of employees with fixed term contract, the higher the share of employees with fixed-term contracts because they could not find a permanent job: this is natural because the second variable measures a part of the first one. However, both indicators have been kept in the analysis as they concern two different aspects of flexibility. The same high correlation is present also for 2006, 2007. No other high correlations are recorded.
Table 5, 6 and 7 present the correlation matrices for 2006, 2007 and 2008, respectively.

2005	totemp~x	fixjob_m	epr_m	eptepr_m	epc_m	shpart~e	partim~b	overtime	hwactual	evenwk_m	nightwk	satwk	sunwk	shiftwk	hourreas	pare~w_m	leavreas
totemplfix	1																
fixjob_m	0.9368	1															
epr_m	0.2574	0.1987	1														
eptepr_m	0.3243	0.3998	-0.0098	1													
epc_m	0.0069	0.0174	-0.0113	0.4053	1												
shpartime	0.212	0.2595	0.4039	0.1378	0.234	1											
partimejob	0.0775	-0.0591	-0.0957	0.261	0.2224	-0.0604	1										
overtime	0.0073	-0.1965	0.1888	-0.2168	0.0237	-0.0666	0.527	1									
hwactual	-0.1257	-0.0186	0.0862	-0.0852	0.0025	-0.2026	-0.5305	-0.5613	1								
evenwk_m	-0.0236	-0.15	-0.0847	-0.1757	-0.2361	-0.213	-0.0624	0.1281	-0.1334	1							
nightwk	-0.0547	-0.1589	0.0936	-0.5825	-0.3586	-0.1438	-0.3846	-0.0549	-0.0256	0.4687	1						
satwk	0.0361	0.0006	0.0337	-0.131	-0.0164	0.2322	-0.4547	-0.4365	0.1193	0.4056	0.5028	1					
sunwk	-0.3261	-0.38	-0.075	-0.4746	-0.2213	-0.1121	-0.3471	-0.1459	0.1813	0.6195	0.6399	0.6431	1				
shiftwk	0.138	0.075	0.3252	-0.3646	0.0012	0.043	-0.4662	0.0261	0.2421	0.3301	0.5928	0.3695	0.3622	1			
hourreas	-0.0565	-0.1876	-0.1964	-0.1398	-0.2283	0.0686	0.5078	0.5333	-0.5707	0.3965	0.0946	-0.2405	0.163	-0.1145	1		
parenthw_m	-0.3551	-0.3675	-0.1504	-0.614	-0.3314	-0.4206	-0.0258	0.249	0.1786	0.0624	0.2559	-0.3279	0.1499	0.2738	0.1868	1	
leavreas	-0.2889	-0.1893	-0.3732	-0.3216	-0.3308	-0.1822	-0.1457	0.044	-0.1196	-0.1865	-0.0843	-0.1196	-0.0578	-0.233	-0.0285	0.2479	1

Table 4 -Correlation matrix of basic indicators for 2005

2006	totemp~x	fixjob_m	epr_m	eptepr_m	epc_m	shpart~e	partim~b	overtime	hwactual	evenwk_m	nightwk	satwk	sunwk	shiftwk	hourreas	pare~w_m	leavreas
totemplfix	1																
fixjob_m	0.92	1															
epr_m	0.2195	0.1941	1														
eptepr_m	0.2678	0.3723	0.0162	1													
epc_m	0.0112	0.0303	-0.0533	0.2762	1												
shpartime	0.1407	0.1685	0.518	0.1099	0.1244	1											
partimejob	0.0088	-0.1065	-0.1404	0.1756	0.1815	-0.0465	1										
overtime	0.0699	-0.1382	0.2131	-0.1788	0.0479	0.032	0.4906	1									
hwactual	-0.195	-0.0045	0.0883	-0.0586	0.019	-0.1757	-0.6124	-0.54	1								
evenwk_m	-0.0374	-0.0929	-0.1791	-0.2212	-0.2488	-0.1948	-0.0074	0.0691	-0.1034	1							
nightwk	0.0352	-0.0912	-0.0278	-0.6425	-0.3534	-0.1345	-0.2849	-0.0602	-0.0565	0.4331	1						
satwk	0.1062	0.0384	-0.005	-0.1539	-0.0244	0.133	-0.3642	-0.3779	0.1576	0.4263	0.5587	1					
sunwk	-0.2622	-0.3388	-0.1195	-0.5301	-0.2455	-0.1136	-0.2258	-0.0396	0.1118	0.6226	0.6714	0.6317	1				
shiftwk	0.1897	0.1617	0.1751	-0.415	-0.0518	-0.08	-0.4652	0.0123	0.363	0.2563	0.6025	0.3916	0.3075	1			
hourreas	-0.0843	-0.165	-0.2038	-0.1928	-0.2961	0.0802	0.5889	0.5445	-0.6039	0.3964	0.1378	-0.2306	0.2147	-0.1856	1		
parenthw_m	-0.2562	-0.254	-0.1417	-0.572	-0.204	-0.4178	0.015	0.1642	0.1161	0.0621	0.2837	-0.2745	0.1562	0.3894	0.1607	1	
leavreas	-0.1827	-0.1474	-0.3862	-0.2623	-0.2909	-0.2642	-0.1832	-0.0699	0.0247	-0.1988	-0.1052	-0.1414	-0.0787	-0.1651	-0.0942	0.2837	1

Table 5- Correlation matrix of basic indicators for 2006

2007	totemp~x	fixjob_m	epr_m	eptepr_m	epc_m	shpart~e	partim~b	overtime	hwactual	evenwk_m	nightwk	satwk	sunwk	shiftwk	hourreas	pare~w_m	leavreas
totemplfix	1																
fixjob_m	0.9416	1															
epr_m	0.301	0.2436	1														
eptepr_m	0.3692	0.4291	-0.0188	1													
epc_m	0.1059	0.0671	0.0421	0.3178	1												
shpartime	0.1934	0.2142	0.5112	-0.0384	0.075	1											
partimejob	0.0797	-0.0516	-0.1042	0.2418	0.2515	-0.0132	1										
overtime	0.0766	-0.1367	0.2287	-0.1062	0.0817	0.0413	0.5118	1									
hwactual	-0.1912	-0.0362	0.068	-0.1422	-0.0657	-0.2224	-0.5951	-0.5625	1								
evenwk_m	-0.0142	-0.0932	-0.208	-0.2077	-0.1833	-0.1159	0.0389	0.0665	-0.1434	1							
nightwk	0.0679	-0.0527	0.0171	-0.5648	-0.1998	-0.0392	-0.1991	-0.0454	-0.1265	0.441	1						
satwk	0.1234	0.0803	0.0534	-0.1935	0.0265	0.1958	-0.2761	-0.3497	0.1123	0.4447	0.6258	1					
sunwk	-0.2407	-0.3222	-0.079	-0.5494	-0.1669	-0.0174	-0.2052	-0.0119	0.0634	0.6447	0.7247	0.6846	1				
shiftwk	0.1597	0.1302	0.1924	-0.4832	-0.0372	-0.0544	-0.3789	-0.0255	0.3542	0.2343	0.5712	0.3526	0.3455	1			
hourreas	-0.0703	-0.1843	-0.2118	-0.1963	-0.2566	0.0847	0.5433	0.598	-0.5739	0.4392	0.1128	-0.227	0.2019	-0.1663	1		
parenthw_m	-0.2896	-0.2789	-0.162	-0.5358	-0.2552	-0.3827	0.0389	0.1121	0.0973	0.0232	0.2734	-0.2673	0.1228	0.3952	0.1901	1	
leavreas	-0.3246	-0.2192	-0.3889	-0.2037	-0.3659	-0.2986	-0.2643	-0.0915	0.1237	-0.3165	-0.2519	-0.2932	-0.1782	-0.2221	-0.0894	0.2428	1

Table 6- Correlation matrix of basic indicators for 2007

2008	totemp~x	fixjob_m	epr_m	eptepr_m	epc_m	shpart~e	partim~b	overtime	hwactual	evenwk_m	nightwk	satwk	sunwk	shiftwk	hourreas	pare~w_m	leavreas
totemplfix	1																
fixjob_m	0.2596	1															
epr_m	0.0284	0.2311	1														
eptepr_m	0.1498	0.4303	-0.1392	1													
epc_m	-0.0112	-0.0964	-0.0182	0.1743	1												
shpartime	0.227	0.2188	0.4236	-0.1576	0.0699	1											
partimejob	0.5854	-0.0525	-0.1454	0.2362	0.1952	-0.0493	1										
overtime	0.6088	-0.1138	0.2069	-0.1257	0.0584	0.0668	0.5292	1									
hwactual	-0.8197	-0.0937	0.0907	-0.1174	0.0545	-0.2394	-0.6234	-0.5596	1								
evenwk_m	0.1827	-0.1434	-0.1202	-0.1609	-0.0556	-0.1111	-0.022	0.09	-0.1887	1							
nightwk	0.0212	-0.0891	0.0777	-0.5549	-0.2051	-0.0013	-0.2129	-0.0922	-0.1444	0.419	1						
satwk	-0.11	0.1137	0.0873	-0.1384	0.0642	0.2648	-0.2624	-0.3503	-0.0028	0.4269	0.6145	1					
sunwk	-0.0021	-0.3314	-0.0207	-0.5174	-0.1412	0.0482	-0.1341	0.0277	-0.0882	0.6466	0.7136	0.6429	1				
shiftwk	-0.4285	-0.0098	0.1523	-0.4996	0.114	-0.1488	-0.3773	-0.0813	0.3719	0.2469	0.5319	0.3148	0.3023	1			
hourreas	0.5833	-0.2115	-0.1383	-0.2298	-0.2233	0.1181	0.5057	0.6728	-0.5952	0.4539	0.0945	-0.1871	0.3072	-0.2031	1		
parenthw_m	-0.2109	-0.3214	-0.1465	-0.5544	-0.1915	-0.366	0.0172	0.135	0.122	-0.0191	0.2297	-0.3452	0.0767	0.4271	0.1872	1	
leavreas	-0.3486	-0.2112	-0.403	-0.1833	-0.4091	-0.3137	-0.2916	-0.1691	0.2338	-0.2601	-0.1693	-0.1607	-0.0263	-0.0368	-0.1918	0.2587	1

Table 7- Correlation matrix of basic indicators for 2008

3. Methodological Assumptions

Nardo et al. (2005) define a composite indicator as "a mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis" (p.7). Following this logic, we summarize the concept of Flexible Contractual Arrangements into one number; encompassing all dimensions which are both relevant and for which data are available. To create this composite indicator the methodological guidelines of Nardo et al. (2005) were thoroughly followed.

A composite indicator is ultimately the sum of all its parts; hence the methodological assumptions made for its calculation need to be clear and well justified. In general, different methodological decisions can be taken, provided that they are supported by the relevant theoretical framework and their effects on the indicators' final values are carefully evaluated. In the present exercise, methodological choices need to be made with respect to the following elements:

a) the structure of the composite indicator
b) the imputation of missing data.
c) the aggregation rule
d) the standardization formula
e) the weighting system

Based on the theoretical framework developed in cooperation with Unit D1 in DG Employment, the composite indicator has been constructed following the methodological assumptions specified below and already adopted for the construction of the LLL, AMLP and MSS composite indicator (Mascherini; 2008: Mascherini and Manca, 2009, Governatori, Manca and Mascherini, 2009 see above).

3.1 The structure of the FCA composite indicator

The composite indicator for Flexible Contractual Arrangements (FCA) has a simple structure. It is composed by three dimensions:

1. *Regulations on dismissals and use of flexible contractual forms - external flexibility* which covers six indicators;
2. *Flexibility of working time - internal flexibility* which includes 10 indicators, albeit counting for 6 (see 2.2 above).
3. *Flexibility of work organisation to help combine work and family responsibilities* which includes 3 indicators.

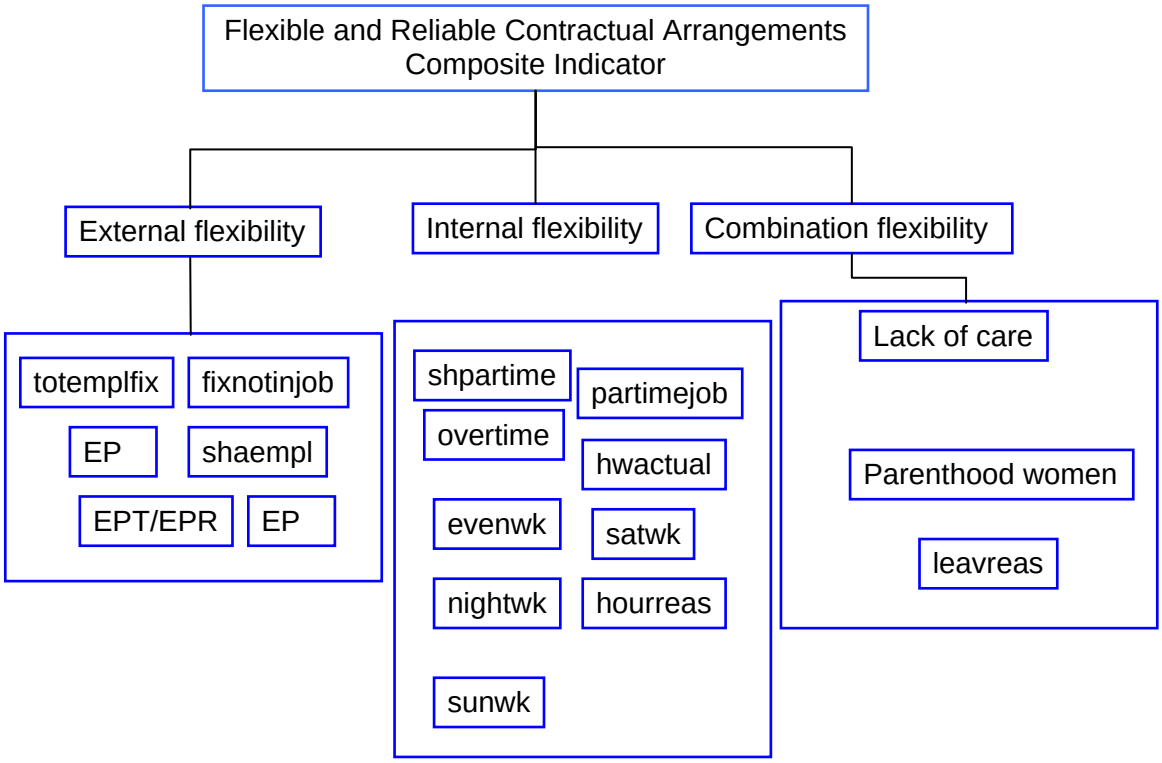


Figure 1: The structure of the Flexible and Reliable Contractual Arrangement Composite Indicator 2005-2008

The effect of alternative structures of the composite indicator on the final ranking of countries is discussed in the section on uncertainty analysis below.

3.2 The imputation of data

The construction of a composite indicator requires, ideally, a complete dataset. However, statistical methodologies have been developed to enable the calculation of composite indicators even in presence of missing data.

As discussed above, in this exercise missing data were mainly tackled by country exclusion and imputation. The main problems concern four indicators: first, the employment impact of parenthood for women and, second, the three indicators on Employment Protection Legislation. The former is completely lacking for 2008 and hence had to be imputed for all Member States considered for that year, whereas the three indicators on strictness of EPL were lacking for the whole period for four Member States (Lithuania, Romania, Cyprus and Malta), leading to their exclusion from the sample[11].

[11] As EPL plays a key role in the overall assessment of flexibility in this exercise.

Apart from these variables, the number of missing data was rather limited (see table 7) and could be tackled through specific statistical techniques.

Year	totemplff	fixnotjob	shaempl	EPR	EPT/EPR	EPC	shpartin	partimejol	overtime	hwactual	evenwk	nightwk	satwk	sunwk	shiftwk	hourreas	lack of c	parenthoo	parenthd	leavreas
2005	0%	7%	0%	26%	26%	26%	0%	0%	4%	0%	15%	11%	11%	11%	11%	0%	0%	7%	4%	4%
2006	4%	7%	0%	26%	26%	26%	4%	4%	0%	0%	4%	0%	0%	0%	0%	4%	19%	4%	4%	0%
2007	0%	4%	0%	26%	26%	26%	0%	0%	0%	0%	7%	4%	4%	4%	4%	0%	11%	4%	4%	4%
2008	0%	4%	0%	22%	22%	22%	0%	4%	4%	0%	7%	4%	4%	4%	4%	0%	11%	100%	100%	0%

Table 7: Number of missing data by indicators

Three such methods exist: 1) case deletion, 2) single imputation and 3) multiple imputations. The first one omits missing records from the analysis. It has the advantage of maintaining the original data-set and the disadvantage of reducing the overall number of observations. The two remaining approaches consider missing data as part of the analysis and aim at imputing values through different techniques[12].

In order to use a simple approach and to avoid "black box" techniques such as, for instance, multiple imputations a three steps strategy has been applied:

1. For each member state, whenever possible, the value of the previous/following year (or the average of values over all available years) was imputed to the missing indicator. This is a hot-deck type of approach, based on proximity criteria. This technique has been used in 39 cases.
2. For each member state, whenever an indicator was missing throughout the entire period considered, missing values were imputed through the regression imputation method. The number of missing data imputed through this technique was 5 for each year.
3. The effect of imputed values on the final ranking of countries was tested through an extensive MCMC simulation (see section on uncertainty analysis below).

3.3 The standardization scheme

As the 19 basic indicators are expressed with different scales, they need to be standardized as a pre-condition for their aggregation. Different standardization techniques are available (Nardo et al., 2005). In this exercise the Min-Max approach adapted for a 4 years time-coverage has been applied. Each original indicator q has then been standardized based on the following rule (where t indicates the year and c the country)

$$I^{t}_{qc} = \frac{x^{t}_{qc} - \min_{c}(x_{q}^{2005-2008})}{\max_{c}(x_{q}^{2005-2008}) - \min_{c}(x_{q}^{2005-2008})} \cdot 1000 .$$

[12] Single imputation methods include hot deck or mean/median/mode substitution and regression imputation (Little and Schenker, 1994; Little, 1997; Little and Rubin, 2002) whereas multiple imputations include Markov Chain Monte Carlo (MCMC) algorithm (Gilks, Richardson and Spiegelhalter, 1996; Schafer, 1999; Rubin and Schenker,1986).

Using this method, all indicators have been rescaled in such a way as to lie between 0 (laggard $x_{qc}=\min_c(x^{2005\text{-}2008}_q)$) and 1000 (leader, $x_{qc}=\max_c(x^{2005\text{-}2008}_q)$). Where $\max_c(x^{2005\text{-}2008}_q)$ and $\min_c(x^{2005\text{-}2008}_q)$ are respectively the maximum and the minimum value of the indicator over all countries and years considered. In order to assess the robustness of the composite indicator, alternative standardization methods have been applied in the context of the uncertainty and sensitivity analysis (see below).

3.4 The weighting scheme

Following on the standardization process, it is important to ensure that for every indicator a higher score corresponds to a better performance of the country, so that the different indicators can be meaningfully aggregated. As discussed above, in the present case some of the indicators contribute negatively to the overall score of the FCA index, according to specific theoretical arguments. Therefore, those indicators had to be transformed by multiplying them by -1 to make sure the above condition was fulfilled. No transformation was needed for the other indicators.

The weighting scheme adopted for the construction of the FCA index consists of attributing equal weights to all indicators *within the same dimension*. This strategy avoids rewarding those dimensions which include more indicators (e.g. internal flexibility) relative to those with fewer ones (e.g. flexibility of work organization to help combine work and family responsibilities). There is only exception to this rule which concerns *atypical work*, where all five variables have been weighted as one single variable. As a result, all dimensions included in the index are equally important, although individual variables do not necessarily have the same weight across different dimensions. Table 8 below presents the numerical values of the weights.

Table 8 - Weighting scheme for the FCA composite indicator

Dinemsion	Dimension weight	Basic indicator	Direction	Description	Normalised weight
Regulations on dismissals and use of flexible contractual forms (external flexibility)					
	1/6	totemplfix	+	Total employees in fixed-term only contracts as % of persons in employment	0.056
	1/6	fixjob	-	Share of employees with fixed-term contracts because they could not find a permanent job	0.056
	1/6	shaempl	+	Share of self-employment in total employment	0.056
	1/6	epr	-	Strictness of rules on regular contrac	0.056
	1/6	ept/epr	+	Ratio of strictness of rule on temporary contracts vs regular ones'	0.056
	1/6	epc	-	Strictness of rules on collective dismissals	0.056
Flexibility of working time -internal flexibility					
	1/6	shpartime		Share of employees in part-time	0.056
	1/6	partimejob	-	Share of employees in part-time because they could not find full-time job	0.056
	1/6	overtime	+	Overtime work : Share of employees for whom overtime is main reason for actual hours worked being different from usual hours worked	0.056
	1/6	hwactual	+	Numbers of hours actually worked during the reference week (Coefficient of variation)	0.056
		evenwk	+	Share of workers doing evening work	0.011
		nightwk	+	Share of workers doing night work	0.011
	1/6	satwk	+	Share of workers doing saturday work	0.011
		sunwk	+	Share of workers doing Sunday work	0.011
		shiftwk	+	Share of workers doing shift work	0.011
	1/6	hourreas	+	Variable working hours: share of employees for whom variable hours is the main reason for actual hours worked being different from usual hours worked	0.056
Flexibility of work organization to help combine work and family responsibility					
	1/3	lack	-	Inactivity and part-time work due to lack of suitable care services for children and other dependants	0.111
	1/3	parenthw	-	Employment impact of parenthood - women	0.111
	1/3	leavreas	-	Share of workers who have left last job/business for looking after children, other personal or family responsibilities and education or training	0.111

3.3 The aggregation rule

The issue of aggregation of the information conveyed by the different dimensions into a composite index comes together with the weighting. Different aggregation rules are possible. Sub-indicators could be summed up (e.g. linear aggregation), multiplied (geometric aggregation) or aggregated using non linear techniques (e.g. multi-criteria analysis). Each technique implies different assumptions and has specific consequences.

In this paper, for each year considered, a simple linear aggregation rule was adopted, implying that basic indicators are aggregated according to the structure of the indicator (see above 3.1) and the following formula:

$$Y_c^t = \sum_{i=1}^{3} w_i \sum_{j=1}^{k_i} w_j^* I_{ijc}^t$$

Where t is the year of reference, w are the weights of the 3 dimensions, w^* are the weights of basic indicators within each dimension, k_i is the number of indicators included in dimension i, I the basic indicator and c the country index. Different aggregation rules have been tested within the sensitivity analysis.

4. Results

After having defined the structure, the weighting scheme and the standardization procedure, the computation of the FCA composite indicator can be performed. This section presents and discusses the results of the indicator in terms of Member States' ranking over the four-years period considered.

Table 9 presents the total score of the composite indicator as well as of its three dimensions (i.e. External Flexibility, Internal Flexibility and Work-life combination flexibility) by country for 2005. A higher score should be interpreted as a sign that the corresponding Member State has more Flexible and Reliable Contractual Arrangements and hence is relatively more in line with the flexicurity approach. However, as with every composite indicator, one should always keep in mind that the overall score may mask divergent scores across dimensions and/or individual variables. In 2005 Portugal, Greece, Poland, France and Finland rank in the top five positions. The ranking of Greece in the first position is driven by the high scores obtained in the sub-dimensions of external flexibility and work-life combination flexibility, whereas its score on internal flexibility is not particularly good. The situation of Portugal is different because it ranks in the 2nd and 3rd position in the 2nd and 3rd sub-dimensions, respectively. Overall, in 2005 Member States do not seem to cluster around the geographical groups which are often mentioned in the literature (Nordic, Mediterranean etc.). For instance, the Netherlands, Slovenia, Spain, Belgium and Bulgaria rank in intermediate-to-upper positions. The Anglo-Saxon countries do not group together as the UK ranks 12th and Ireland 23rd[13]. Eastern Member States, with the exception of Poland, Slovenia and Bulgaria, rank in intermediate-to-lower positions. Sweden ranks in the 20th position due to a very low score in external flexibility.

Table 9 – 2005 Flexible Contractual Arrangement and its sub dimensions composite indicator

Flexible Contractual Arrangement			External flexibility			Internal flexibility			Working condition flexibility		
Rank	Country	CI 2005	Rank	Country	CI 2005	Rank	Country	CI 2005	Rank	Country	CI 2005
1	PT	626.30	1	EL	223.62	1	SI	163.54	1	PT	311.35
2	EL	622.55	2	FR	204.31	2	PT	153.47	2	FR	292.85
3	PL	617.11	3	ES	194.00	3	PL	144.12	3	EL	274.16
4	FR	597.19	4	PL	186.26	4	CZ	140.74	4	BE	271.12
5	FI	594.78	5	BE	184.92	5	BG	139.22	5	PL	262.56
6	NL	562.06	6	IT	183.90	6	SK	136.29	6	IT	259.31
7	SI	544.55	7	IE	180.96	7	NL	132.93	7	NL	252.10
8	ES	533.50	8	FI	179.68	8	HU	123.24	8	BG	244.46
9	BE	532.39	9	UK	171.93	9	EL	117.02	9	FI	244.36
10	BG	526.67	10	HU	168.32	10	IE	116.91	10	ES	236.13
11	IT	520.98	11	EE	168.15	11	EE	116.26	11	LT	226.78
12	UK	516.45	12	AT	162.58	12	LT	115.62	12	SK	223.31
13	LT	499.73	13	DK	156.15	13	UK	114.14	13	SI	221.42
14	DK	495.69	14	PT	153.73	14	FI	108.24	14	DE	206.50
15	SK	495.27	15	LU	152.90	15	LU	101.19	15	LU	202.59
16	AT	492.49	16	CZ	149.53	16	DE	98.66	16	AT	202.31
17	DE	466.45	17	SI	147.87	17	AT	96.84	17	DK	197.86
18	LU	461.20	18	LT	146.74	18	DK	96.65	18	SE	185.27
19	EE	460.26	19	NL	137.88	19	SE	95.12	19	UK	174.45
20	SE	455.79	20	DE	135.15	20	ES	88.80	20	EE	151.18
21	CZ	444.60	21	BG	134.16	21	IT	68.59	21	HU	144.48
22	HU	441.66	22	SE	129.73	22	BE	68.57	22	CZ	135.47
23	IE	367.04	23	SK	124.96	23	FR	64.54	23	IE	59.48

Moving to results for 2006 (see table 10) the country ranking changes somewhat. In particular, Finland moves up by 4 positions and ranks 1st in 2006 mainly due to an improved score in the sub-dimension of internal flexibility. Portugal still ranks in a high

[13] Ireland is heavily penalized in the sub-dimension of work-life combination flexibility (where it ranks in the last position) whereas it ranks around intermediate positions in the remaining two sub-dimensions.

position, albeit moving from first to second. Denmark improves considerably relative to 2005 by moving up by 11 positions and reaching the third score overall. This is mainly due to an improvement score in the sub-dimension of work-life combination flexibility. Slovenia ranks in the 4th position thanks its first score on internal flexibility and a good score on work-life combination. The Netherlands, Poland, France and the UK rank in intermediate-to-upper positions. Greece moves downwards by 10 positions relative to 2005 and it now ranks 11th. Germany deteriorates considerably reaching the last position, due to a very low score in all the three sub-dimensions. Belgium and Bulgaria also worsen their ranking (albeit to a lesser extent, i.e. by 5 positions). Apart from the above mentioned cases, Members States tend to improve their ranking[14]

Table 10 – 2006 Flexible Contractual Arrangement and its sub dimensions composite indicator

Flexible Contractual Arrangement			External flexibility			Internal flexibility			Work-life condition flexibility		
Rank	Country	CI 2006	Rank	Country	CI 2006	Rank	Country	CI 2006	Rank	Country	CI 2006
1	FI	598.30	1	EL	222.47	1	SI	178.05	1	DK	274.25
2	PT	591.06	2	FR	204.14	2	PL	176.65	2	PT	270.97
3	DK	585.47	3	IE	195.36	3	FI	172.27	3	NL	260.30
4	SI	580.53	4	ES	194.21	4	UK	170.18	4	FR	257.39
5	NL	565.67	5	BE	183.59	5	NL	167.95	5	IT	254.03
6	PL	563.91	6	IT	183.46	6	PT	165.07	6	SI	252.87
7	FR	559.72	7	PL	182.71	7	SE	152.98	7	FI	245.85
8	UK	552.22	8	FI	180.18	8	CZ	152.16	8	LT	239.76
9	IT	525.74	9	UK	170.49	9	BG	151.14	9	AT	229.81
10	LT	522.16	10	DK	168.28	10	EE	143.86	10	BE	228.46
11	EL	517.98	11	HU	164.95	11	DK	142.94	11	LU	227.08
12	AT	514.02	12	AT	161.17	12	SK	141.56	12	UK	211.54
13	LU	495.71	13	EE	158.71	13	LT	138.53	13	SK	204.78
14	IE	489.75	14	PT	155.02	14	EL	126.68	14	PL	204.55
15	BE	485.61	15	LU	152.97	15	IE	125.54	15	BG	195.56
16	BG	477.82	16	SI	149.61	16	AT	123.04	16	SE	182.64
17	SK	469.89	17	CZ	148.77	17	HU	122.28	17	ES	172.01
18	ES	467.74	18	LT	143.87	18	DE	121.46	18	DE	170.70
19	SE	465.02	19	NL	137.42	19	LU	115.67	19	IE	168.85
20	EE	445.27	20	DE	132.64	20	ES	101.51	20	EL	168.83
21	CZ	443.47	21	BG	131.11	21	FR	98.19	21	EE	142.71
22	HU	425.67	22	SE	129.40	22	IT	88.25	22	CZ	142.54
23	DE	424.80	23	SK	123.55	23	BE	73.55	23	HU	138.44

As regards 2007 (see table 11 below) no large deviations are recorded compared to 2006. Finland still ranks first, followed by Denmark, the Netherlands, Portugal and Slovenia. Only slight changes are recorded such as, for instance, France switching its position with Poland, Austria, Ireland and Greece moving up by 3 and 1 (Greece) positions respectively, whereas Italy, Luxemburg and Slovakia register some worsening. New Member States still predominantly cluster in the lower end of the ranking.

[14] E.g. Luxemburg moves from 18th to 13th position and Lithuania moves up by 3 positions.

Table 11 – 2007 Flexible Contractual Arrangement and its sub dimensions composite indicator

Flexible Contractual Arrangement			External flexibility			Internal flexibility			Work-life condition flexibility		
Rank	Country	CI 2007	Rank	Country	CI 2007	Rank	Country	CI 2007	Rank	Country	CI 2007
1	FI	589.55	1	EL	222.35	23	UK	163.69	23	UK	196.76
2	DK	571.53	2	FR	205.56	22	SK	140.94	22	SK	181.56
3	NL	570.93	3	ES	195.67	21	SI	176.55	21	SI	235.32
4	PT	567.56	4	IE	187.17	20	SE	148.84	20	SE	175.10
5	SI	562.95	5	BE	185.04	19	PT	158.96	19	PT	252.29
6	FR	552.73	6	PL	184.23	18	PL	171.02	18	PL	188.37
7	PL	543.63	7	IT	183.62	17	NL	172.25	17	NL	253.46
8	UK	532.56	8	FI	180.74	16	LU	116.55	16	LU	190.27
9	AT	525.18	9	UK	172.12	15	LT	140.94	15	LT	188.31
10	EL	516.81	10	HU	171.55	14	IT	79.62	14	IT	239.64
11	IT	502.87	11	DK	171.37	13	IE	130.50	13	IE	157.97
12	IE	475.64	12	EE	161.84	12	HU	121.34	12	HU	126.79
13	BE	473.14	13	AT	161.78	11	FR	104.44	11	FR	242.73
14	LT	471.16	14	CZ	156.39	10	FI	175.77	10	FI	233.04
15	BG	469.63	15	PT	156.31	9	ES	99.62	9	ES	157.14
16	LU	457.93	16	LU	151.11	8	EL	123.81	8	EL	170.65
17	SE	454.83	17	SI	151.08	7	EE	140.79	7	EE	127.27
18	ES	452.42	18	NL	145.23	6	DK	139.50	6	DK	260.66
19	SK	448.32	19	LT	141.92	5	DE	121.31	5	DE	170.68
20	EE	429.91	20	DE	134.14	4	CZ	144.55	4	CZ	117.61
21	DE	426.13	21	SE	130.89	3	BG	152.01	3	BG	187.16
22	HU	419.68	22	BG	130.46	2	BE	73.15	2	BE	214.95
23	CZ	418.56	23	SK	125.82	1	AT	125.04	1	AT	238.35

Also in 2008 (see table 12), Member States' ranking does not present significant changes relative to 2007. The Netherland ranks first, followed by Denmark and Finland. France, Portugal and the UK maintain their ranking among the upper positions. On the other hand, Slovenia worsens significantly, by moving down to 9th position, whereas Germany improves its own by moving from the 21st to the 17th position. Also in 2008 changes tend to concentrate on the upper end of the ranking. New Member States still predominantly cluster in the lower end.

Table 12 – 2008 Flexible Contractual Arrangement and its sub dimensions composite indicator

Flexible Contractual Arrangement			External flexibility			Internal flexibility			Work-life condition flexibility		
Rank	Country	CI 2008	Rank	Country	CI 2008	Rank	Country	CI 2008	Rank	Country	CI 2008
1	NL	651.17	1	EL	214.45	1	NL	189.77	1	NL	264.41
2	DK	604.17	2	FR	212.36	2	FI	182.85	2	PT	264.09
3	FI	593.81	3	BE	205.15	3	PL	171.76	3	DK	262.06
4	FR	584.03	4	IE	202.83	4	SI	169.07	4	FR	258.61
5	PT	571.43	5	UK	197.58	5	UK	165.81	5	IT	252.91
6	UK	568.79	6	NL	196.99	6	PT	160.12	6	AT	245.64
7	AT	555.32	7	DK	194.30	7	SE	156.15	7	BE	243.45
8	EL	526.95	8	IT	187.70	8	EE	148.94	8	FI	226.85
9	SI	522.47	9	FI	184.11	9	CZ	148.89	9	SI	211.55
10	BE	518.40	10	AT	179.54	10	DK	147.81	10	UK	205.40
11	IT	518.05	11	ES	175.22	11	BG	147.26	11	BG	203.72
12	PL	517.54	12	EE	172.81	12	LT	140.82	12	LU	201.01
13	LU	479.40	13	HU	168.72	13	SK	138.51	13	PL	186.32
14	BG	478.84	14	LU	166.27	14	AT	130.14	14	EL	183.36
15	IE	474.74	15	PL	159.45	15	EL	129.13	15	ES	181.83
16	SE	473.98	16	CZ	153.79	16	DE	125.69	16	DE	180.17
17	DE	457.48	17	DE	151.62	17	HU	123.05	17	SE	176.50
18	ES	452.39	18	PT	147.21	18	IE	113.16	18	SK	172.88
19	EE	450.86	19	LT	141.88	19	FR	113.06	19	LT	161.26
20	LT	443.97	20	SI	141.85	20	LU	112.13	20	IE	158.74
21	SK	434.02	21	SE	141.33	21	ES	95.34	21	HU	129.14
22	HU	420.91	22	BG	127.86	22	IT	77.44	22	EE	129.12
23	CZ	408.27	23	SK	122.63	23	BE	69.79	23	CZ	105.58

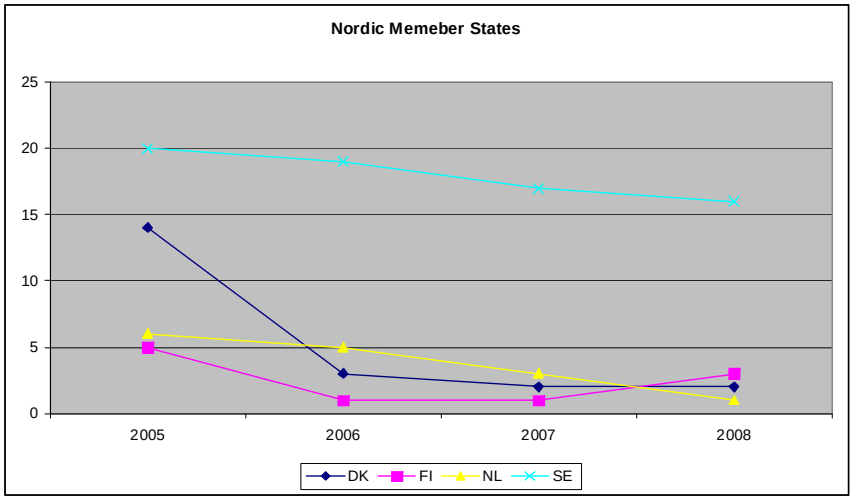
Table 13 and figure 2 below track the evolution of member states' ranking over the period considered (i.e. 2005-2008). Overall, the ranking varies only moderately, with differences mainly concentrated on 2005 relative to the following three years. The biggest variations concern the Nordic and Mediterranean Member States, i.e. Greece ranking first in 2005

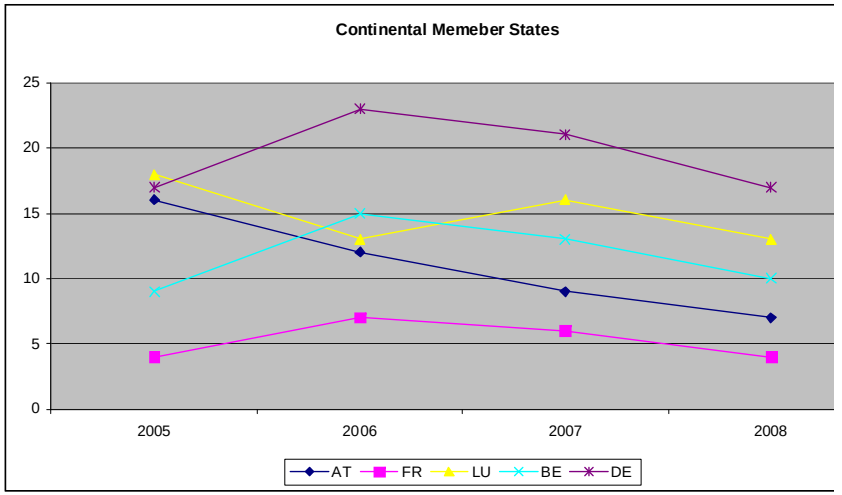
while falling in intermediate-to-upper positions in 2006-2008 and Finland and Denmark ranking among first positions in 2006-2008. However, Members States do not systematically cluster around those geographical grouping which are often mentioned in the literature, although some indication in that direction can be seen, e.g. the emergence of a 'Nordic cluster' in top positions (including Netherlands, Denmark and Finland, but with the exception of Sweden) in the last three years considered.

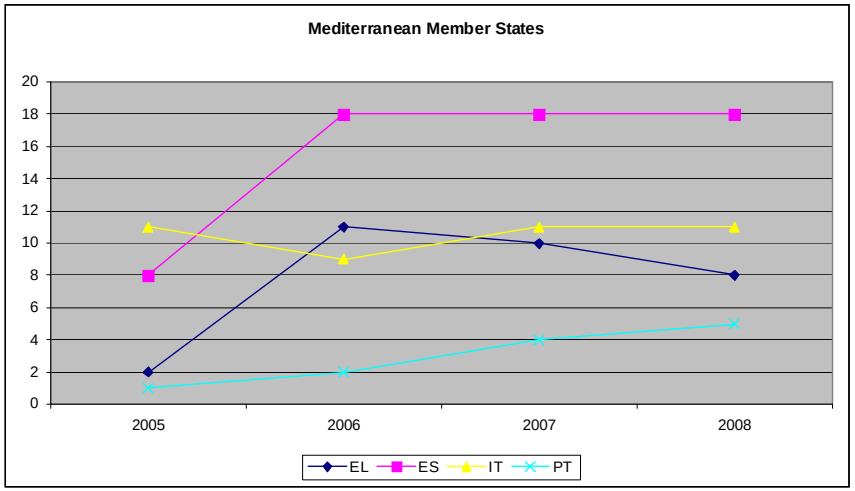
Table 13 - Comparison of the rankings 2005-2008

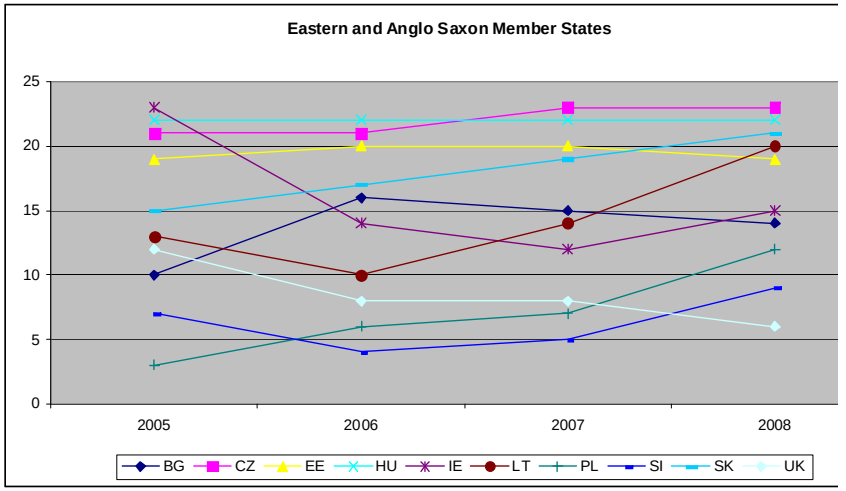
Country	CI 2005	CI 2006	CI 2007	CI 2008
AT	16	12	9	7
BE	9	15	13	10
BG	10	16	15	14
CZ	21	21	23	23
DE	17	23	21	17
DK	14	3	2	2
EE	19	20	20	19
EL	2	11	10	8
ES	8	18	18	18
FI	5	1	1	3
FR	4	7	6	4
HU	22	22	22	22
IE	23	14	12	15
IT	11	9	11	11
LT	13	10	14	20
LU	18	13	16	13
NL	6	5	3	1
PL	3	6	7	12
PT	1	2	4	5
SE	20	19	17	16
SI	7	4	5	9
SK	15	17	19	21
UK	12	8	8	6

Figure 2 - Ranking Comparison 2005-2008 for each cluster









5. Uncertainty and Sensitivity Analysis.

In order to assess the robustness of the FCA composite indicator the main sources of uncertainties underlying its calculation as well as the sensitivity of country scores/rankings to the methodological approach adopted are assessed. This section presents the main conclusions of this uncertainty and sensitivity analysis. Further details are available in the Annex.

Every composite index, including this one, involves subjective judgments in several steps of the calculation procedure, such as the selection of indicators, the choice of aggregation model, the imputation of missing data and the weights applied to the indicators. This implies that the quality and reliability of an index as well as the uncertainties associated with the methodology followed for its construction need to be evaluated. Moreover, to ensure the validity of the policy conclusions based on the index, it is important to analyze its sensitivity to alternative methodological assumptions. A combination of uncertainty and sensitivity analyses can help to gauge the robustness of the indicator's results, to increase its transparency and to help frame the debate about its use.

Five main sources of uncertainty can be highlighted and their combined effect on country rankings needs to be tested:

1) Data Normalization
2) Weighting Scheme
3) Composite Indicator Formula (Aggregation Rule)
4) Inclusion/Exclusion of Basic Indicators
5) Imputation of Missing Data via MCMC.

Essentially, uncertainty analysis is carried out through computer simulations. First, the five above mentioned sources of uncertainty are turned into 5 input factors with uniform probabilities across the different alternatives they can take, i.e. the different approaches and methods (see table 13). Then, all possible combinations of input factors are simulated. This would result, in principle, in 20000 combinations with corresponding sets of indicators' values and country rankings related to the indicator 2005-2008. However only 12000 of them produce a valid scenario and are, therefore, retained in the analysis.

Table 14 - Uncertainty factors for the FCA composite indicator

X_1	Standardization
1	Z-Score
2	Min-Max

X_2	Weighting Scheme
1	Equal Weight
2	Predetermined set of Weights

X_3	Aggregation Rule
1	Linear

X_4	Excluded Sub-Indicator
1	Indicator 1 omitted
2	Indicator 2 omitted
3	Indicator 3 omitted
...	...
19	Indicator 19 omitted

X_5	Imputation of Missing Data via MCMC
1	Sample 1 of the set of missing data randomly simulated.
2	Sample 2 of the set of missing data randomly simulated.
3	Sample 3 of the set of missing data randomly simulated.
…	…
100	Sample 100 of the set of missing data randomly simulated..

Following on this, for every country the distribution of possible rankings across the 12000 simulations is assessed. The variability of these distributions can be considered as the result of the uncertainty underlying the construction process of the composite indicator. It is more appropriate to discuss ranks and not scores because of the non-normal nature of data. The results of the simulations can then be organized in a frequency matrix and the overall FCA indicator is calculated across the 12000 scenarios. Besides the frequency matrix, the median rank per country was selected as benchmark to be compared with the rank recorded in the FCA composite indicator as presented in section 3 above. Frequency distribution matrices are presented below

On table 16 an example of frequency distribution of a country rank over the 12000 scenarios is presented. A colour code is used to distinguish different frequencies as illustrated in table 15:

Table 15 - Colour Codes

	Frequency lower than 10%
	Frequency between 10% and 20%
	Frequency between 20% and 35%
	Frequency between 35% and 50%
	Frequency higher than 50%
bold	Position in the FCA composite indicator
Italic	median
Red	mode of the distribution

Moreover, **Bold**, *Italic* and Red represent the country rank in the FCA composite indicator, the median and the mode of the 12000 simulations, respectively. For example Finland in 2005 has a distribution encoded as follows, Table 15:

Table 16 – Frequencies of Finland performance in the 12000 scenarios in 2005.

	1	2	3	4	5
FI	8.08%	25.30%	*24.25%*	20.37%	**18.01%**

This means that the country is ranked in positions 1st to 5th among the 12000 simulations performed. In particular, Finland is ranked in position 1st with a frequency lower than 10%, in position 2nd to 3rd with a frequency between 20% and 35%, in position 5th with a frequency between 10% and 20%. Position 2nd is the mode, the median falls in the 3rd position, whereas the country ranks 5th in the composite indicator.

In the following tables, the frequency matrices for the period 2005-2008 are presented. Due to the huge number of simulations performed, only frequencies higher than 10% are shown. A first consideration is that the overall ranking is quite stable; in fact, considering the main indicator, over the whole set of 12000 simulations all countries clustered unambiguously. This is true in particular for the first and the last positions which show a very low degree of variability across the three years. The imputation of missing data affects the results of the uncertainty analysis only to a minor extent. In this section a general overview of the results of uncertainty analysis is given, whereas the specific situation of each country is commented in the country profile section.

The frequency matrix for 2005 is shown in Figure 3. Although the results of uncertainty analysis for this year show some variability in the ranking of countries, the overall situation does not contradict the ranking of the composite indicator presented in table 2. In particular, Portugal is the leader of the ranking in the 30% of the 12000 different scenarios performed. A similar situation holds for Greece which is ranked in the top 3 positions in 70% of the cases. The ranking of Poland is quite robust as this country ranks in the first 3 positions in more than 90% of cases. France presents a high variability in the ranking which goes from the 3rd to the 6th position, the mode falls in the 5th position in almost 34% of the cases, whereas it ranks 4th in the main scenario shown in section 4 above. The ranking of Finland varies from 1st to 5th, with median in 3rd position and 5th position in the (main) indicator. The Netherlands, Slovenia and Spain present a high

ranking variability[15]. Apart from these cases, for most countries ranking is robust and it is concentrated in their position in the index in general in 50% of scenarios considered.

Results for 2006 highlight some increase in the variability of countries' ranking although the overall situation does not contradict the composite indicator presented above. Despite the increase in variability, most countries record a rank which varies across a maximum of +/- 2 positions compared with that identified in the composite indicator. This trend is confirmed in more than 90% of the 12000 different scenarios considered. The ranking of Ireland shows the highest variability implying that some assumptions in the sources of uncertainty affect the country ranking in some cases. For some countries, such as the UK, Italy, Austria, or Belgium, ranks vary within 3 positions in more than 55% of cases. Other countries present a bi-modal distribution, such as Germany or Bulgaria, but in both cases the median of the distribution corresponds to the position recorded in the composite indicator.

The uncertainty analysis results for 2007, despite presenting a slight increase in the variability of countries' ranking, confirms for most of them the positions of the composite indicator. This is not the case for Portugal, which ranks from the 3rd to the 9th position in 50% of the cases, or Poland which ranks from the 2nd to the 9th position in 70% of the cases. Three other countries present a similar situation: Denmark, the Netherlands and Slovenia which rank between the 2nd and 6th position in 75% of cases, between the 2nd and 6th in 60% of cases and between the 4th and 9th in 60% of cases, respectively. This ranking variability is mainly due to the weak correlations within the basic indicators. However, most countries record a ranking which does not deviate more than +/- 3 positions relative to the one in the composite indicator. In particular, Greece moves between the 10th and 12th position in more than 55% of cases. Germany, Czech Republic and Hungary have their ranking varying by three positions in more than 70% of cases. Spain, Italy and Slovakia show a bi-modal distribution of the frequencies, but in all cases the median of the distribution corresponds to the position recorded in the composite indicator.

Figure 6 shows the results of the uncertainty analysis for 2008. Although these show some variability in the ranking of countries, for most of them the positions of the composite indicator shown in table 12 are confirmed. Exceptions are France, which ranks from the 4th to the 6th position in 75% of cases and Germany which ranks between the 16th and the 17th position in 35% of cases. Ranking variability across 4 positions is observed for the UK, Belgium, Italy, Poland, Estonia and Sweden. This is mainly due to imputation of missing data and weak correlations among basic indicators. Luxemburg, Bulgaria and Ireland present a bi-modal distribution of frequencies, but in all cases the median corresponds to the position in the main composite indicator.

[15] The Netherland ranks between the 6th and the 8th positions in 60% of cases, Slovenia falls between the 7th and the 8th position in 255 of the cases while Spain ranks between the 6th ad 8th position in 34% of cases.

Ranking is particularly robust for Finland, which ranks 1st in 79% of cases, and Denmark where the ranking only varies within 2 positions in more than 60% of cases.

Figure 3 - Uncertainty Analysis frequency matrix for 2005

2005		PT	EL	PL	FR	FI	NL	SI	ES	BE	BG	IT	UK	LT	DK	SK	AT	DE	LU	EE	SE	CZ	HU	IE
Rank	1	**30.02%**	16.47%	37.55%	3.86%	8.08%																		
Rank	2	12.38%	**24.67%**	35.11%	0.90%	25.30%																		
Rank	3	9.28%	33.08%	**21.82%**	7.79%	24.25%																		
Rank	4	17.86%	18.28%		**26.26%**	20.37%																		
Rank	5	20.93%			33.54%	**18.01%**																		
Rank	6				19.53%		**34.36%**		13.25%															
Rank	7						26.68%	**13.66%**	11.18%	12.06%														
Rank	8						11.09%	11.88%	**8.64%**	25.41%	10.78%	11.26%												
Rank	9									**30.59%**	14.76%	17.26%	10.92%											
Rank	10									15.02%	**16.25%**	21.27%	14.34%											
Rank	11										14.58%	**16.23%**	16.17%	9.31%										
Rank	12										10.98%	9.58%	**16.63%**	15.33%	10.50%	8.88%								
Rank	13										7.22%		11.66%	**24.13%**	15.09%	9.08%								
Rank	14										10.22%		10.59%	18.76%	**17.39%**	8.68%	12.49%							
Rank	15													10.23%	17.77%	**11.70%**	16.10%	13.69%						
Rank	16														14.20%	11.33%	**11.18%**	17.69%						
Rank	17															12.28%		**24.63%**	12.02%	16.48%				
Rank	18																	11.50%	**14.30%**	33.83%	13.45%			
Rank	19																		12.92%	**23.27%**	11.69%	16.26%	14.29%	
Rank	20																		15.03%	9.15%	**14.70%**	11.53%	23.79%	
Rank	21																		9.33%		20.18%	**22.73%**	22.03%	9.37%
Rank	22																		24.48%		21.83%	23.61%	**18.34%**	5.11%
Rank	23																						9.73%	**79.20%**

Figure 4 - Uncertainty Analysis frequency matrix for 2006

2006		FI	PT	DK	SI	NL	PL	FR	UK	IT	LT	EL	AT	LU	IE	BE	BG	SK	ES	SE	EE	CZ	HU	DE
Rank	1	**69.54%**	14.20%		7.49%																			
Rank	2	16.29%	**16.91%**	16.96%	13.87%		27.70%																	
Rank	3	7.62%	10.78%	**21.01%**	28.53%		11.03%																	
Rank	4		11.73%	14.65%	**18.83%**		14.20%	6.18%																
Rank	5		7.69%	22.31%	12.70%	**19.48%**	10.92%	5.16%																
Rank	6		10.48%	11.74%		8.43%	**10.87%**	26.85%	11.85%															
Rank	7					17.67%	14.28%	**22.76%**	13.64%		7.00%													
Rank	8					14.92%		9.43%	**31.02%**	7.40%	11.98%													
Rank	9					10.04%		13.17%		**23.22%**	17.05%	5.88%	9.87%											
Rank	10					10.86%		5.90%		13.67%	**25.97%**	10.61%	13.35%											
Rank	11									29.91%	17.18%	**8.40%**	13.91%											
Rank	12									9.88%	11.05%	15.36%	**18.34%**		7.60%	15.98%								
Rank	13											8.38%	4.39%	**17.08%**	7.58%	30.22%			8.05%					
Rank	14											12.59%		13.52%	**5.26%**	26.28%	7.86%		9.88%					
Rank	15											7.89%		19.00%	5.94%	**7.64%**	20.71%	10.47%	10.23%					
Rank	16													9.96%	5.37%		**22.88%**	21.31%	10.80%	7.88%				
Rank	17													10.33%	8.91%		9.53%	**16.39%**	14.93%	17.23%				
Rank	18													9.46%	6.87%		6.64%	14.08%	**14.08%**	17.93%	5.51%	7.33%		
Rank	19														7.51%		10.66%	8.08%	10.78%	**17.53%**	11.26%	4.04%	10.80%	
Rank	20														4.73%		5.42%		5.13%	11.41%	**22.84%**	13.43%	11.40%	14.33%
Rank	21														3.48%		10.50%			7.62%	13.71%	**27.24%**	16.52%	8.77%
Rank	22														2.60%					8.97%	18.23%	19.41%	**26.71%**	14.00%
Rank	23														8.13%						20.80%	12.65%	25.88%	**19.09%**

Figure 5 - Uncertainty Analysis frequency matrix for 2007

2007		FI	DK	NL	PT	SI	FR	PL	UK	AT	EL	IT	IE	BE	LT	BG	LU	SE	ES	SK	EE	DE	HU	CZ
Rank	1	70.56%																						
Rank	2	13.84%	**13.91%**	22.68%				13.95%		12.57%														
Rank	3		18.40%	**16.12%**	11.64%			14.68%		15.68%														
Rank	4		14.35%	13.88%	**12.78%**	13.58%	19.55%	9.74%		5.06%														
Rank	5		22.00%	13.18%	4.33%	**19.63%**	15.33%	8.77%		2.35%														
Rank	6		14.32%	17.73%	6.97%	5.82%	**19.43%**	12.78%		10.04%														
Rank	7				9.53%	6.04%	14.58%	**20.33%**	17.13%	8.63%		12.28%												
Rank	8				5.94%	16.08%			**16.66%**	21.11%	4.62%	5.86%												
Rank	9				10.37%	12.15%			17.95%	**15.14%**	8.97%	9.93%												
Rank	10								18.08%	7.68%	23.57%	11.28%		7.28%										
Rank	11										13.18%	**37.32%**	10.11%	11.10%										
Rank	12										11.97%		**15.98%**	26.14%	14.77%									
Rank	13												10.78%	**34.11%**	15.95%	10.58%		10.56%						
Rank	14												9.08%	8.11%	**21.30%**	14.24%		11.54%	11.48%					
Rank	15												11.17%			**26.92%**	5.25%	11.68%	7.13%			8.14%	9.53%	
Rank	16															16.99%	**12.87%**	16.62%	5.58%			5.89%	6.24%	
Rank	17															12.36%	11.44%	**14.47%**	15.71%		8.14%	6.28%	5.91%	
Rank	18																17.59%		**17.84%**	11.80%	7.67%	4.51%	9.19%	
Rank	19																9.98%		9.78%	**19.53%**	8.40%	13.90%	6.83%	
Rank	20																5.73%			20.04%	**15.50%**	14.52%	8.52%	
Rank	21																16.63%			7.30%	14.25%	**20.10%**	13.70%	11.16%
Rank	22																			4.66%	18.79%	6.73%	**27.47%**	24.53%
Rank	23																			10.69%	22.47%	8.77%	9.29%	**36.58%**

Figure 6 - Uncertainty Analysis frequency matrix for 2008

2008		NL	DK	FI	FR	PT	UK	AT	EL	SI	BE	IT	PL	LU	BG	IE	SE	DE	ES	EE	LT	SK	HU	CZ
Rank	1	79.14%	2.56%	16.78%																				
Rank	2	12.18%	45.99%	12.33%		10.29%		12.63%																
Rank	3		21.90%	**33.71%**		9.18%	12.26%	11.13%																
Rank	4		12.48%	16.32%	**31.08%**	4.48%	13.88%	15.08%																
Rank	5				32.31%	**11.63%**	22.48%	10.74%																
Rank	6				16.58%	8.43%	**33.43%**	22.66%																
Rank	7					21.21%		**18.74%**					24.43%											
Rank	8					10.12%			**11.09%**	9.25%	19.95%	21.19%	13.99%											
Rank	9								9.88%	**13.49%**	24.38%	21.15%	14.03%											
Rank	10								9.81%	10.84%	**27.75%**	16.82%	17.33%											
Rank	11								12.22%	15.02%	10.09%	**17.93%**	13.97%			14.18%								
Rank	12								11.13%	29.80%	7.92%	9.42%	**9.59%**			9.62%		9.24%						
Rank	13								10.72%	12.20%				**11.30%**	15.85%	7.72%	11.14%	4.48%	17.10%					
Rank	14													11.90%	11.43%	11.03%	13.35%	9.93%	18.35%					
Rank	15													9.28%	8.83%	**15.30%**	21.58%	8.93%	7.52%					
Rank	16													9.52%	6.84%	8.89%	**17.12%**	19.44%	7.52%		10.73%			
Rank	17													5.04%	7.31%	9.13%	9.06%	**18.33%**	8.07%	14.86%	10.22%			
Rank	18													5.18%	6.70%	4.44%		9.42%	**15.21%**	12.02%	15.72%			
Rank	19													7.03%	8.57%	5.08%				**19.77%**	13.30%	14.74%		
Rank	20													7.01%	12.70%					10.50%	**23.42%**	11.52%		
Rank	21													9.60%	12.69%							**27.31%**	14.15%	
Rank	22													10.64%	5.54%							12.49%	**31.45%**	19.27%
Rank	23													9.94%	0.03%							16.88%	18.33%	**49.95%**

6. Conclusions

As a fourth and last step in the process of construction of a set of composite indicators on flexicurity within a joint DG EMPL-JRC project, this paper presents a composite indicator on Flexible and Reliable Contractual Arrangements (FCA), i.e. one of the four dimensions of flexicurity identified by the Commission (see COM(2007) 359). The indicator is based on 19 basic indicators and three sub-dimensions, i.e. i) Regulations on dismissals and use of flexible contractual forms - external flexibility; ii) Flexibility of working time - internal flexibility; iii) Flexibility of work organisation to help combine work and family responsibilities – work-life balance combination flexibility. The indicator covers a four years period (2005 to 2008). The large set of indicators included, going well beyond the strictness of employment protection legislation whereby labour market flexibility is often measured, makes this exercise broader and more comprehensive than any previous attempt to characterise the flexibility dimension within a holistic attempt to measure flexicurity.

All indicators used are based on institutional EU-level data sources. Results point to considerable heterogeneity in FCA across the EU, although Member States are not always grouped across well defined geographical clusters often mentioned in relevant literature (e.g. Southern, Anglo-Saxon etc.). The indicator's country ranking is quite stable over time, in particular in the years 2006-2008, while significant differences can be observed between 2005, on the one hand, and 2006-2008, on the other hand. Uncertainty and sensitivity analyses have been performed in order to test the robustness of the Composite Indicator. Those were based on 12000 different simulated scenarios, generated by considering different options with respect to standardization methods, weighting scheme, aggregation rules and the inclusion/exclusion of basic indicators. Results show that the composite indicator's scores and rankings are overall robust, albeit with some variability mainly due to imputation of missing data and low correlation among basic indicators. On average, ranking variability is higher than in the Life Long Learning and Modern Social Security composite indicators, but lower than in the Active Labour Market Policies one, reflecting the varying presence of missing data.

7. Reference

- European Commission (2001a), Summary Innovation Index, DG Enterprise, European Commission, Brussels.
- European Commission (2006), *Flexibility and security in the EU labour markets*, in Employment in Europe, DG Employment, European Commission, Brussels.
- European Commission (2007), *Working time, work organisation, and internal flexibility -flexicurity models in the EU*, in Employment in Europe, DG Employment, European Commission, Brussels.
- Fagerberg J. (2001), Europe at the crossroads: The challenge from innovation based growth in the Globalising Learning Economy, B. Lundvall and D. Archibugi eds., Oxford Press.
- Freudenberg, M. (2003), Composite indicators of country performance: a critical assessment, OECD, Paris.
- Gilks, W. R., Richardson, S. and Spiegelhalter, D. J. (1996) Markov Chain Monte Carlo in Practice, Chapman and Hall, London
- Governatori, M., Manca A.R. and Mascherini, M. "Towards a set of composite indicators on Flexicurity: The Indicator on Modern Social Security Systems" EUR REPORT 24091 EN.-
- Jamison, D. and Sandbu, M. (2001), "WHO ranking of health system performance", Science, 293, 1595-1596.
- Little R.J.A (1997), Biostatistical Analysis with Missing Data, in Armitage P. and Colton T. (eds.) Encyclopaedia of Biostatistics, London: Wiley.
- Little R.J.A. and Rubin D.B. (2002), Statistical Analysis with Missing Data, Wiley Interscience, J. Wiley& Sons, Hoboken, New Jersey.
- Little R.J.A. and Schenker N. (1994), Missing Data, in Arminger G., Clogg C.C.,and Sobel M.E.(eds.) Handbook for Statistical Modeling in the Social and Behavioral Sciences, pp.39-75, New York:Plenum.
- Mascherini, M., "Towards a set of composite indicators on flexicurity: the lifelong learning composite indicator" EUR REPORT 23516 EN.-
- Mascherini, M., Manca A.R. "Towards a set of composite indicators on Flexicurity: The Composite Indicator on Active Labour Market Policies" EUR REPORT 23957 EN.-
- Nardo, M., Saisana, M., Saltelli, A., and Tarantola, S. (EC/JRC), Hoffman, A. and Giovannini, E., (OECD). (2005). *Handbook on constructing composite indicators: methodology and user guide* OECD Statistics Working Paper.
- Rubin,D.B. and Schenker N. (1986), Multiple imputation for interval estimation from simple random samples with ignorable nonresponse - Journal of the American Statistical Association, Vol. 81, No. 394 (Jun., 1986), pp. 366-374
- Saltelli A. (2002), Making best use of model valuations to compute sensitivity indices, Computer Physics Communications, 145, 280-297.
- Saltelli, A., Chan,K. And Scott, M.. (2000a). *Sensitivity Analysis*. Probability and Statistics Series. New York: John Wiley & Sons.
- Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D. Saisana, M., Tarantola, S., (2008) , *Global Sensitivity Analysis. The Primer*, John Wiley & Sons publishers.

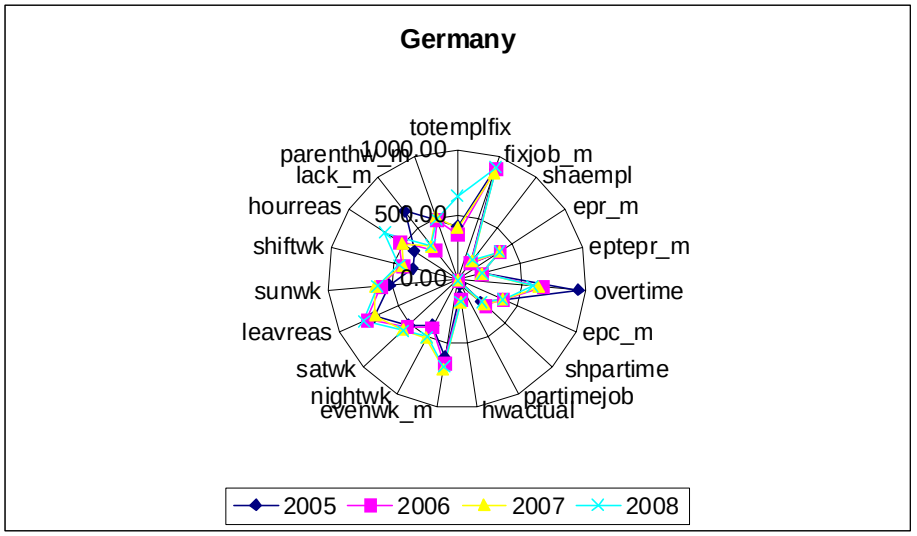
- Saltelli, A., Tarantola S. and Campolongo F. (2000b). *Sensitivity Analysis as an Ingredient of Modelling*. Statistical Science 15:377-395.
- Schafer J.L. (1999), Multiple imputation: a primer, Statistical Methods in Medical Research, Vol. 8, No. 1, 3-15.
- Tarantola S., Jesinghaus J. and Puolamaa M. (2000), Global sensitivity analysis: a quality assurance tool in environmental policy modelling. In Sensitivity Analysis
(eds Saltelli A., Chan K., Scott M.) pp. 385- 397. New York: John Wiley & Sons. - World Economic Forum (2002), Environmental Sustainability Index.
http://www.ciesin_org/indicators/ESI/index.html.

ANNEX 1: COUNTRY PROFILES

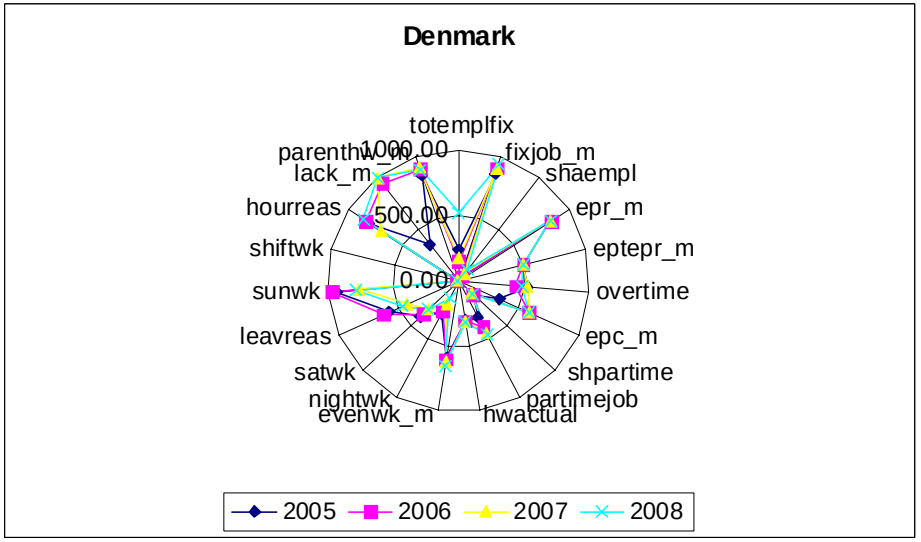
Country Profiles

In this section we analyse the individual country profiles for the 19 basic indicators of the FCA index and the robustness of each country's ranking over the period 2005-2008. In order to ensure comparability of performance, only the normalized values of basic indicators are shown through radar charts. In addition, radar charts showing countries' scores along the three sub-dimensions of the FCA index are presented. For most indicators, a greater value corresponds to a better performance. Exceptions are indicators *fixjob*, *epr*, *epc*, *partimejob*, *lack of care*, *parenthood*, *leavreas* (see above, main text), where a greater value indicates a worse performance. Those variables are reported in italic for the reader's convenience. The radar plot shows the performances in all four years and is supported by a table presenting the normalized values of all basic indicators which are listed using their short name (see table 1 above for further details). In addition, the robustness of the country ranking in the composite index in each year is presented with the results of the uncertainty and sensitivity analysis.

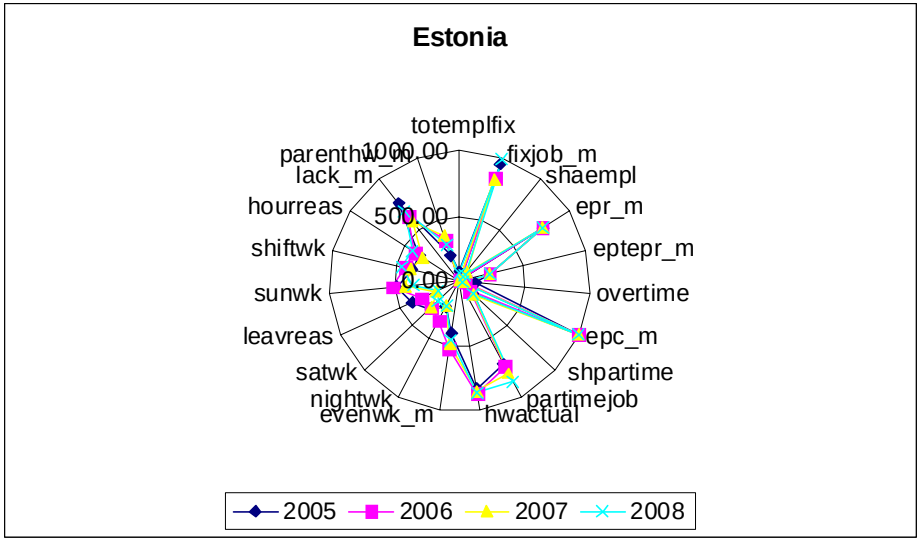
DE	2005	2006	2007	2008
totemplfix	410.25	350.71	394.94	644.28
fixjob_m	895.55	907.91	872.26	914.47
shaempl	160.12	162.02	180.48	196.18
epr_m	389.77	389.77	389.77	389.77
eptepr_m	194.14	194.14	194.14	201.50
overtime	937.77	662.45	629.42	583.32
epc_m	382.90	382.90	382.90	382.90
shpartime	250.91	292.61	285.63	259.82
partimejob	42.71	10.00	10.00	10.00
hwactual	134.37	158.32	176.56	172.61
evenwk_m	608.00	651.69	701.77	681.53
nightwk	400.02	417.88	512.40	503.25
satwk	514.67	531.84	574.37	578.47
leavreas	701.66	767.31	694.21	792.80
sunwk	528.34	591.57	641.18	620.36
shiftwk	353.29	436.46	435.01	465.03
hourreas	399.74	537.05	508.96	666.99
lack_m	667.27	282.97	325.29	334.44
parenthw_m	489.56	486.05	516.64	494.33



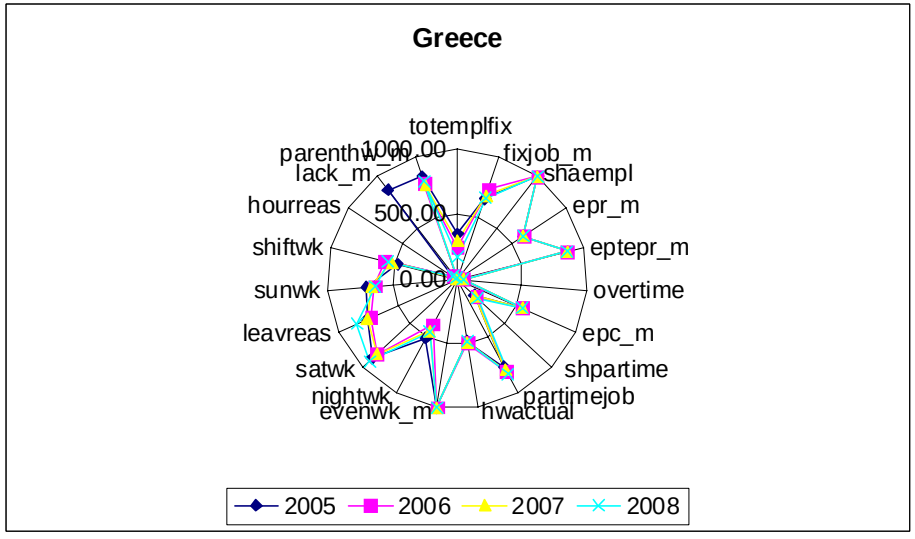
DK	2005	2006	2007	2008
totemplfix	240.38	146.81	174.85	516.70
fixjob_m	862.81	910.42	905.98	939.95
shaempl	24.90	41.75	73.78	106.24
epr_m	834.46	834.46	834.46	834.46
eptepr_m	508.11	508.11	508.11	512.60
overtime	525.26	435.46	526.54	486.08
epc_m	340.00	587.50	587.50	587.50
shpartime	155.69	148.12	137.34	144.09
partimejob	313.20	396.90	450.80	465.91
hwactual	303.67	309.33	311.27	316.66
evenwk_m	593.30	604.85	622.17	652.27
nightwk	279.70	261.12	195.38	146.65
satwk	399.82	370.20	319.17	319.17
leavreas	579.85	627.05	432.17	466.75
sunwk	936.36	969.28	765.04	778.72
shiftwk	10.00	10.00	10.00	10.00
hourreas	808.50	840.05	702.65	866.44
lack_m	351.08	943.17	1000.00	1000.00
parenthw_m	849.85	898.01	913.77	891.76



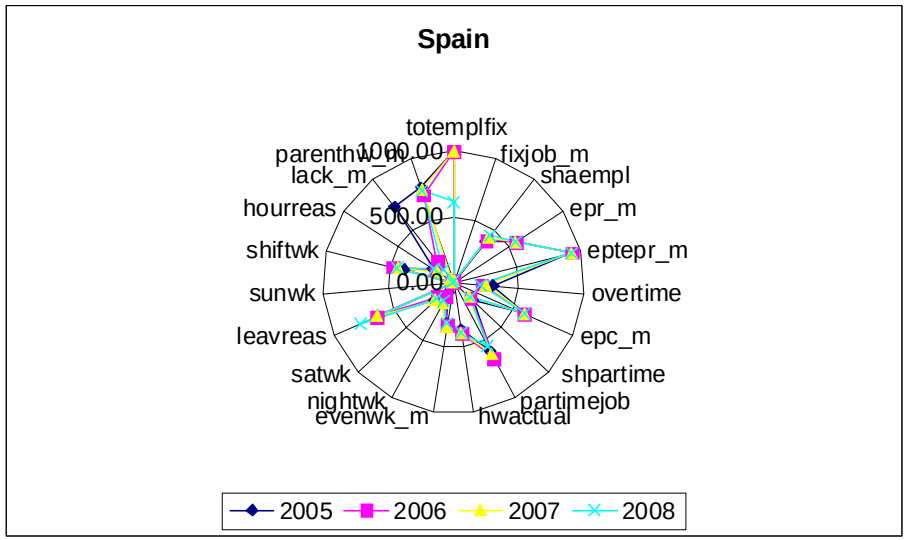
EE	2005	2006	2007	2008
totemplfix	72.48	10.00	10.00	60.76
fixjob_m	950.05	838.72	829.25	988.20
shaempl	14.19	17.91	83.87	64.46
epr_m	756.56	756.56	756.56	756.56
eptepr_m	233.51	233.51	233.51	240.52
overtime	118.73	45.33	38.36	25.10
epc_m	1000.00	1000.00	1000.00	1000.00
shpartime	139.03	107.46	151.28	141.94
partimejob	717.69	740.35	795.63	873.06
hwactual	833.84	866.82	850.93	864.87
evenwk_m	399.70	524.92	486.41	454.86
nightwk	220.31	340.77	210.19	214.23
satwk	307.08	299.72	297.45	226.21
leavreas	396.46	317.19	193.63	179.55
sunwk	489.79	516.82	422.51	357.67
shiftwk	377.91	428.10	389.40	458.07
hourreas	368.24	407.39	336.87	433.70
lack_m	757.09	636.86	583.75	685.20
parenthw_m	207.11	330.33	368.05	297.32



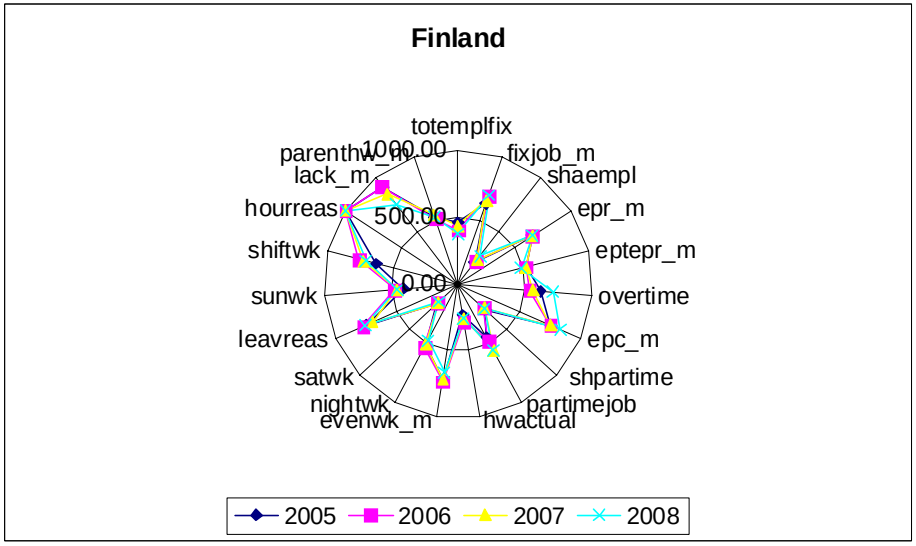
EL	2005	2006	2007	2008
totemplfix	348.84	243.21	295.67	169.72
fixjob_m	650.32	735.23	680.65	663.23
shaempl	1000.00	1000.00	1000.00	1000.00
epr_m	607.25	607.25	607.25	607.25
eptepr_m	870.83	870.83	870.83	872.01
overtime	52.56	41.58	44.57	43.09
epc_m	547.90	547.90	547.90	547.90
shpartime	178.49	198.57	187.20	216.45
partimejob	767.06	808.07	794.55	827.87
hwactual	484.49	498.99	494.69	484.47
evenwk_m	1000.00	1000.00	1000.00	1000.00
nightwk	516.11	397.35	454.13	456.92
satwk	899.09	852.26	849.75	927.73
leavreas	760.02	728.66	763.06	846.34
sunwk	703.67	639.58	664.67	634.71
shiftwk	474.50	575.52	518.99	548.92
hourreas	44.57	40.13	10.00	38.84
lack_m	871.31	10.00	10.00	10.00
parenthw_m	836.12	780.85	762.79	793.94



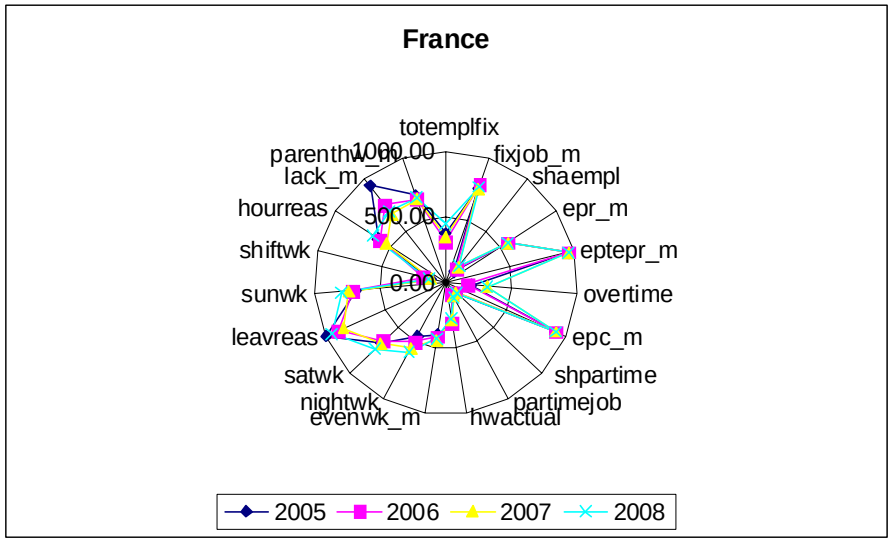
ES	2005	2006	2007	2008
totemplfix	1000.00	1000.00	1000.00	613.85
fixjob_m	10.00	10.00	10.00	10.00
shaempl	400.56	404.42	430.74	448.13
epr_m	565.05	565.05	565.05	565.05
eptepr_m	928.83	928.83	928.83	929.48
overtime	304.99	215.00	245.25	205.12
epc_m	587.50	587.50	587.50	587.50
shpartime	202.60	174.50	161.14	166.93
partimejob	602.21	655.82	615.91	552.88
hwactual	366.30	395.97	388.75	387.03
evenwk_m	319.14	327.74	344.51	315.97
nightwk	83.55	121.00	184.56	160.57
satwk	198.86	160.54	196.51	178.15
leavreas	630.41	645.70	635.06	777.65
sunwk	10.00	10.00	10.00	10.00
shiftwk	389.32	476.73	434.23	446.64
hourreas	184.36	166.76	148.06	181.89
lack_m	727.89	201.95	31.97	120.13
parenthw_m	766.89	700.47	747.19	738.71



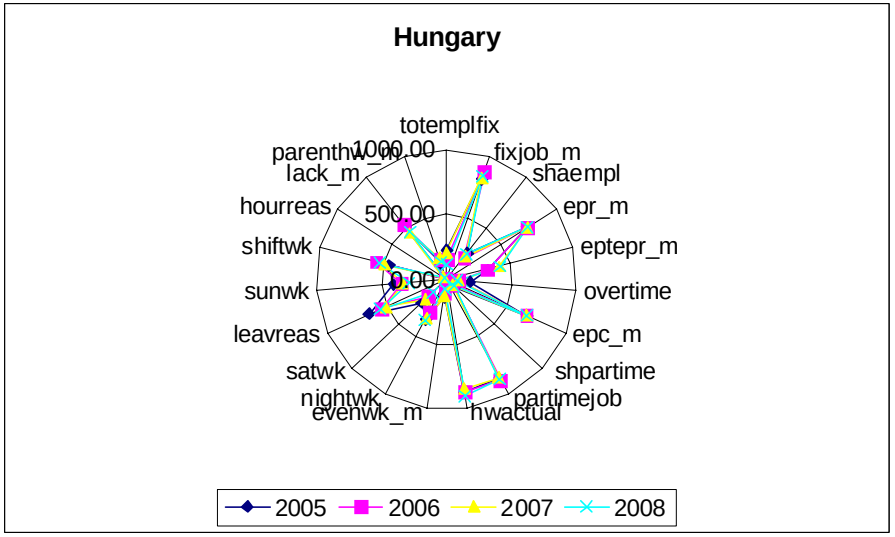
FI	2005	2006	2007	2008
totemplfix	460.14	401.74	433.57	371.32
fixjob_m	636.00	688.86	655.21	698.99
shaempl	203.88	218.46	230.43	266.00
epr_m	659.18	659.18	659.18	659.18
eptepr_m	522.52	522.52	522.52	483.54
overtime	616.72	534.51	557.64	708.37
epc_m	752.50	752.50	752.50	835.00
shpartime	276.27	259.27	262.87	266.90
partimejob	449.60	480.06	562.10	556.50
hwactual	231.91	283.74	258.77	259.25
evenwk_m	728.58	738.19	716.31	665.65
nightwk	511.76	532.83	507.93	474.74
satwk	218.02	206.61	206.45	196.29
leavreas	753.87	774.06	697.67	760.72
sunwk	410.54	474.30	456.89	454.61
shiftwk	625.16	764.29	724.55	709.90
hourreas	1000.00	1000.00	1000.00	1000.00
lack_m	915.61	923.44	852.38	752.82
parenthw_m	529.79	515.15	547.30	528.11



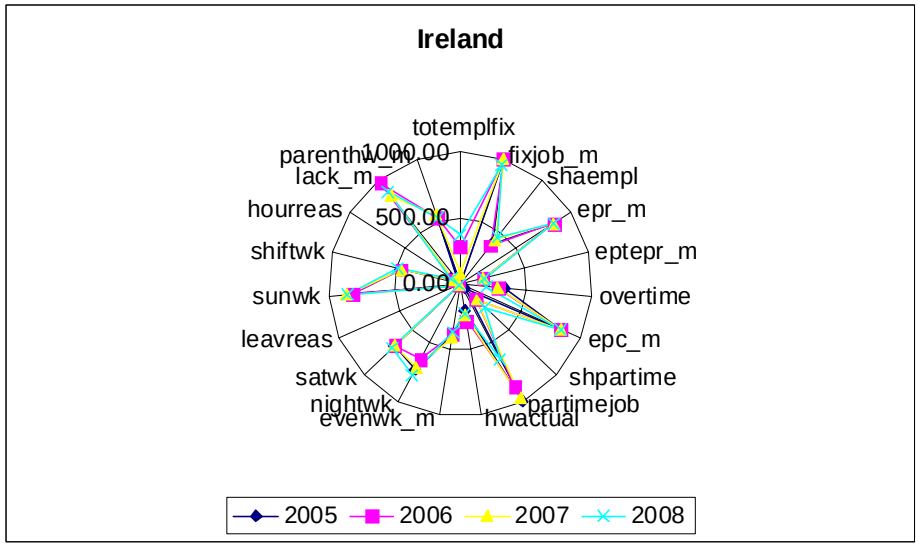
FR	2005	2006	2007	2008
totemplfix	377.42	315.22	352.89	445.01
fixjob_m	752.87	789.58	755.34	771.61
shaempl	105.01	127.39	149.48	163.16
epr_m	561.80	561.80	561.80	561.80
eptepr_m	963.05	963.05	963.05	963.39
overtime	195.24	162.39	313.76	314.16
epc_m	917.50	917.50	917.50	917.50
shpartime	114.80	103.80	107.97	116.00
partimejob	108.18	101.22	121.21	132.58
hwactual	302.55	312.96	289.85	274.86
evenwk_m	396.50	414.13	441.25	430.08
nightwk	457.76	509.36	562.10	595.32
satwk	667.86	650.02	677.13	735.48
leavreas	994.93	892.41	852.30	949.64
sunwk	682.84	711.56	740.34	795.99
shiftwk	119.57	177.93	113.38	135.74
hourreas	614.68	594.47	540.31	659.00
lack_m	934.53	751.61	660.73	695.09
parenthw_m	706.22	672.51	671.53	682.73



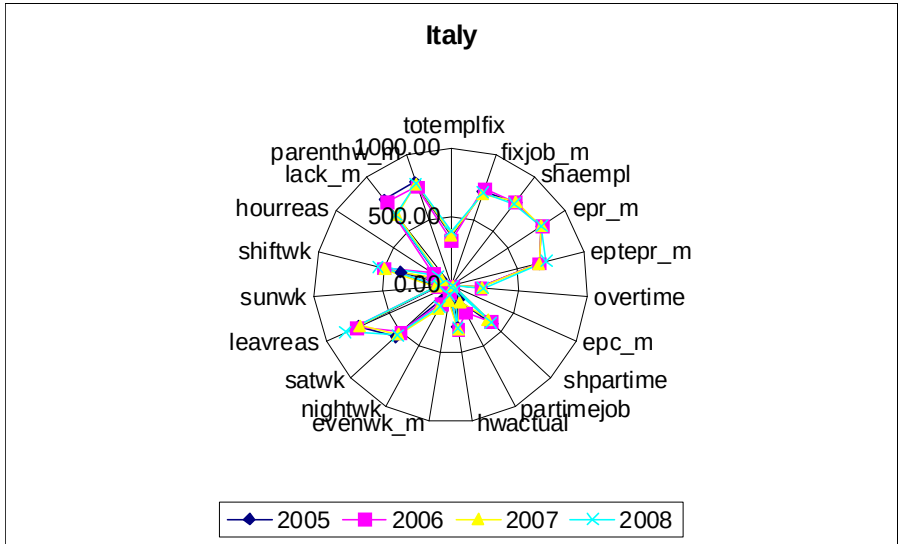
HU	2005	2006	2007	2008
totemplfix	227.17	152.75	206.85	116.06
fixjob_m	818.35	874.42	829.25	842.37
shaempl	254.27	211.88	226.75	248.12
epr_m	740.33	740.33	740.33	740.33
eptepr_m	319.65	319.65	414.73	420.08
overtime	179.89	94.39	91.65	79.39
epc_m	670.00	670.00	670.00	670.00
shpartime	81.10	55.50	60.83	74.68
partimejob	853.27	872.53	851.00	861.52
hwactual	872.49	871.51	848.31	899.98
evenwk_m	137.61	100.61	131.05	72.80
nightwk	346.72	287.98	330.07	351.56
satwk	262.78	191.17	224.02	145.43
leavreas	650.89	546.07	509.33	556.13
sunwk	410.72	347.51	339.04	292.48
shiftwk	456.74	558.34	494.10	532.20
hourreas	10.00	10.00	28.68	20.41
lack_m	522.10	539.86	456.46	460.91
parenthw_m	127.29	160.06	175.30	145.26



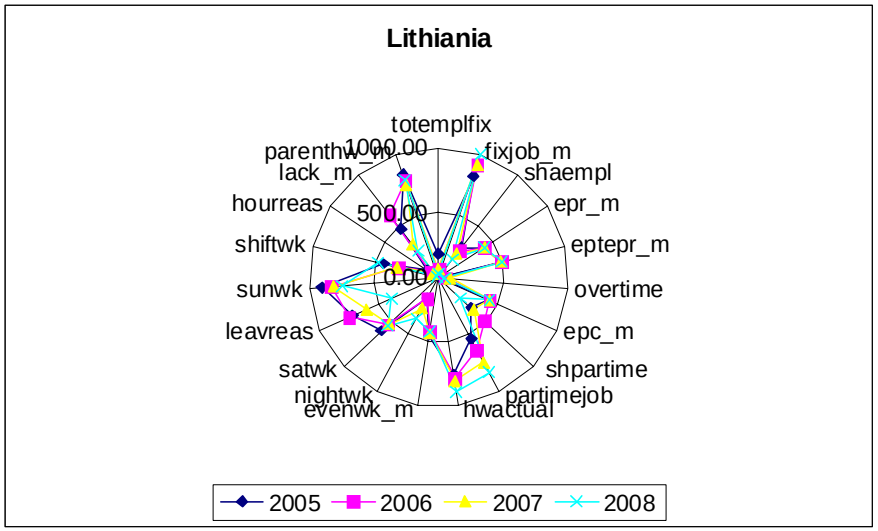
IE	2005	2006	2007	2008
totemplfix	10.00	286.11	83.53	373.55
fixjob_m	1000.00	1000.00	1000.00	959.69
shaempl	390.65	373.75	428.85	453.59
epr_m	844.20	844.20	844.20	844.20
eptepr_m	177.40	177.40	177.40	184.92
overtime	337.72	291.02	282.78	199.17
epc_m	835.00	835.00	835.00	835.00
shpartime	44.32	158.95	170.06	257.29
partimejob	1000.00	878.43	974.25	640.34
hwactual	199.96	279.00	234.96	223.10
evenwk_m	380.15	382.96	405.36	365.42
nightwk	730.57	637.78	711.53	775.37
satwk	682.59	677.20	681.77	707.32
leavreas	10.00	10.00	10.00	10.00
sunwk	818.17	815.53	867.60	857.34
shiftwk	463.50	459.98	458.18	490.19
hourreas	81.85	57.67	62.07	77.86
lack_m	10.00	978.50	852.38	885.56
parenthw_m	515.29	531.16	559.36	533.14



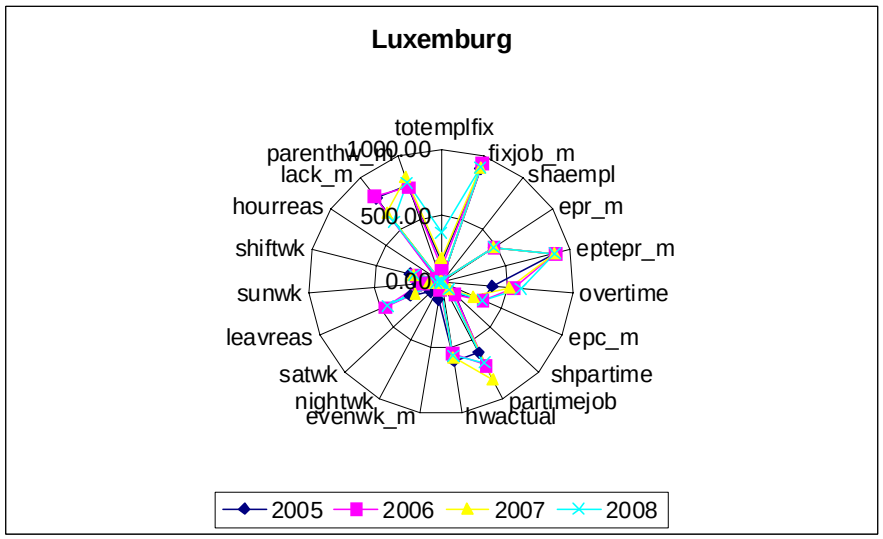
IT	2005	2006	2007	2008
totemplfix	356.81	328.13	366.12	393.93
fixjob_m	718.81	745.03	700.31	714.21
shaempl	770.08	764.60	774.22	753.81
epr_m	789.02	789.02	789.02	789.02
eptepr_m	665.49	665.49	665.49	717.60
overtime	218.96	213.54	228.00	235.10
epc_m	10.00	10.00	10.00	10.00
shpartime	409.61	396.25	370.24	398.05
partimejob	119.62	229.45	139.77	44.63
hwactual	314.88	329.14	326.99	317.41
evenwk_m	93.68	60.42	110.28	73.82
nightwk	111.85	152.90	198.99	177.63
satwk	552.89	504.56	527.89	537.81
leavreas	744.13	758.61	729.71	841.30
sunwk	99.72	91.46	110.17	85.48
shiftwk	382.34	506.58	497.56	548.53
hourreas	88.66	156.87	79.10	114.10
lack_m	792.66	765.66	647.57	654.11
parenthw_m	797.01	762.01	779.47	780.81



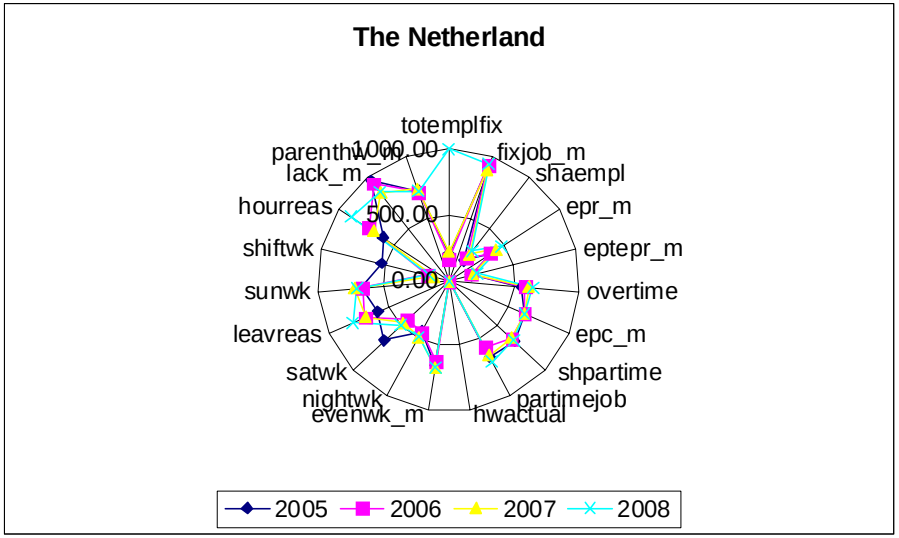
LT	2005	2006	2007	2008
totemplfix	180.51	62.25	59.13	29.65883
fixjob_m	824.47	915.52	919.82	999.8934
shaempl	287.54	263.09	226.69	170.8713
epr_m	422.23	422.23	422.23	422.2295
eptepr_m	494.21	494.21	494.21	498.8285
overtime	10.00	55.72	87.19	50.49954
epc_m	432.40	432.40	432.40	432.4
shpartime	348.48	484.07	366.40	233.7558
partimejob	534.88	632.03	744.16	830.7478
hwactual	757.72	787.28	808.53	894.1665
evenwk_m	453.51	427.89	440.78	424.6688
nightwk	187.56	187.16	273.72	359.9807
satwk	604.80	531.96	524.15	540.5272
leavreas	729.70	756.08	608.19	398.3554
sunwk	904.95	832.03	813.92	745.2477
shiftwk	439.55	318.30	329.13	479.6717
hourreas	102.51	74.92	54.31	15.65398
lack_m	472.96	612.91	329.20	257.5181
parenthw_m	838.38	788.90	757.37	795.4862



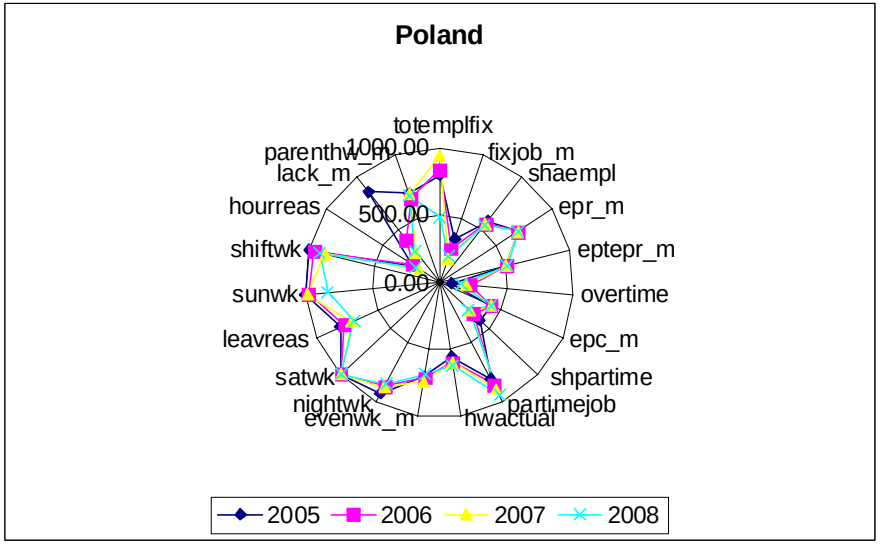
LU	2005	2006	2007	2008
totemplfix	145.47	106.01	175.17	368.8353
fixjob_m	900.09	940.82	910.81	916.3538
shaempl	10.00	10.00	10.00	10
epr_m	470.92	470.92	470.92	470.918
eptepr_m	885.65	885.65	885.65	886.6938
overtime	386.36	545.05	519.46	607.864
epc_m	340.00	340.00	267.40	340
shpartime	130.97	138.71	86.00	81.55229
partimejob	609.10	712.15	836.50	694.4721
hwactual	607.64	549.45	577.03	567.734
evenwk_m	137.08	62.34	10.00	10
nightwk	10.00	10.00	10.00	10
satwk	108.09	10.00	10.00	10
leavreas	257.38	467.24	215.69	443.1056
sunwk	181.95	144.63	94.51	41.51366
shiftwk	242.58	200.12	217.27	211.6827
hourreas	32.81	51.26	10.61	10
lack_m	797.68	822.12	663.29	577.9057
parenthw_m	768.29	754.35	833.47	788.0754



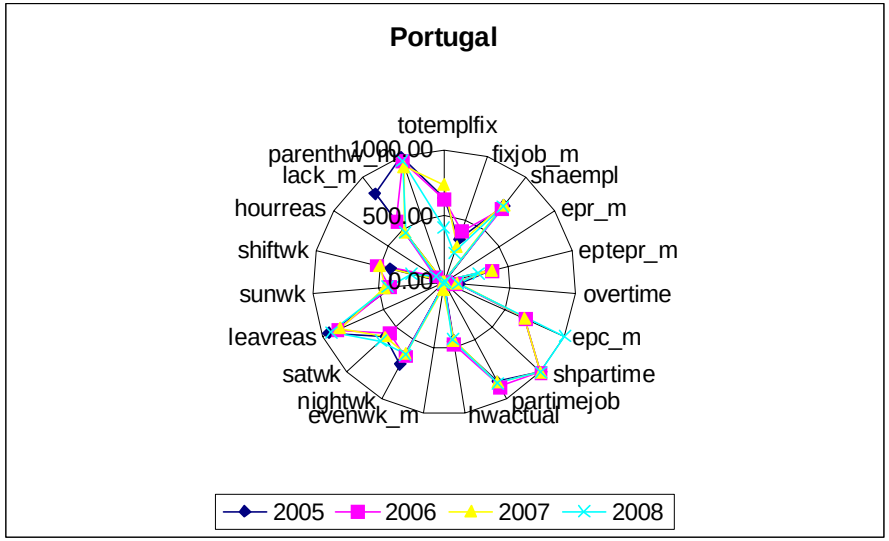
NL	2005	2006	2007	2008
totemplfix	202.02	160.74	216.48	1000
fixjob_m	909.17	920.86	890.51	934.5704
shaempl	191.85	213.19	256.38	283.6667
epr_m	373.54	373.54	428.72	480.6557
eptepr_m	174.79	174.79	191.60	216.577
overtime	555.05	584.19	609.47	640.9336
epc_m	630.40	630.40	630.40	630.4
shpartime	680.21	652.96	645.90	669.5759
partimejob	659.16	580.57	652.57	703.8086
hwactual	10.00	10.00	10.00	10
evenwk_m	653.03	632.09	673.41	669.7961
nightwk	443.12	450.80	491.36	487.4406
satwk	673.99	440.25	478.77	502.2373
leavreas	592.43	702.84	697.04	803.4878
sunwk	671.77	659.84	721.65	705.211
shiftwk	529.85	166.41	121.46	154.3558
hourreas	598.82	725.52	685.16	887.7127
lack_m	962.43	931.55	847.21	855.5863
parenthw_m	714.01	708.33	736.89	720.6103



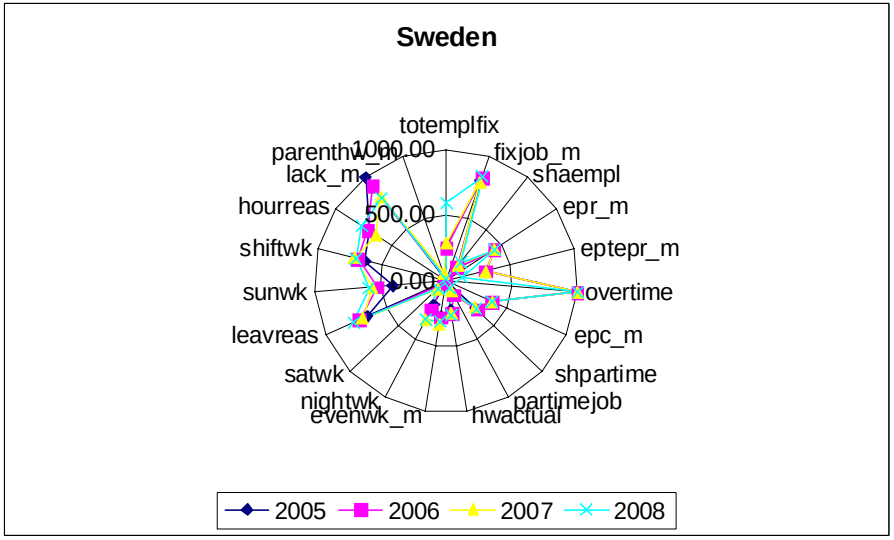
PL	2005	2006	2007	2008
totemplfix	802.51	840.66	948.13	488.8509
fixjob_m	346.06	264.51	189.32	205.9161
shaempl	576.47	555.99	551.13	543.3
epr_m	694.89	694.89	694.89	694.8853
eptepr_m	510.22	510.22	510.22	514.695
overtime	91.78	230.04	197.83	161.9338
epc_m	422.50	422.50	422.50	422.5
shpartime	409.85	341.75	308.45	295.3908
partimejob	807.30	861.20	893.20	946.4159
hwactual	558.55	598.42	602.50	620.6003
evenwk_m	703.03	716.54	743.66	688.3874
nightwk	930.73	875.33	878.77	850.0395
satwk	1000.00	1000.00	1000.00	1000
leavreas	806.34	775.49	714.20	695.9052
sunwk	1000.00	976.89	984.58	836.0652
shiftwk	1000.00	960.01	872.01	917.4616
hourreas	235.11	242.50	180.60	208.9539
lack_m	858.81	404.29	286.18	296.4993
parenthw_m	697.89	661.21	694.96	684.5114



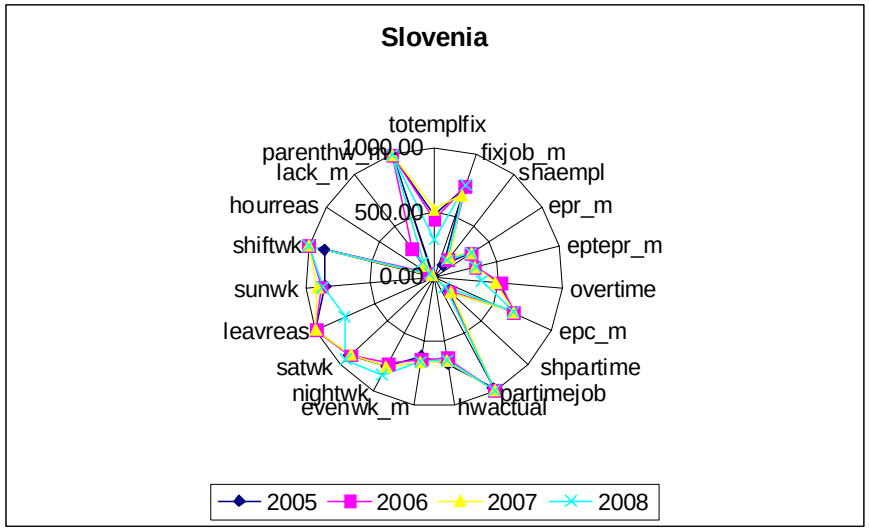
PT	2005	2006	2007	2008
totemplfix	633.62	628.28	736.93	409.7169
fixjob_m	346.06	405.20	286.91	234.0879
shaempl	736.11	705.44	738.37	726.4022
epr_m	10.00	10.00	10.00	10
eptepr_m	371.44	371.44	371.44	269.6078
overtime	111.47	87.00	94.63	106.4527
epc_m	670.00	670.00	670.00	1000
shpartime	1000.00	1000.00	1000.00	1000
partimejob	855.87	897.07	861.91	866.1188
hwactual	452.97	477.40	448.63	439.6607
evenwk_m	10.00	10.00	54.00	10
nightwk	704.71	632.78	616.43	621.0361
satwk	602.14	562.45	607.03	652.1611
leavreas	954.04	884.66	863.33	937.1429
sunwk	394.33	413.40	449.98	429.3333
shiftwk	419.36	524.64	496.36	260.309
hourreas	55.35	81.22	11.32	75.4056
lack_m	848.14	587.67	480.53	471.5253
parenthw_m	1000.00	966.37	926.72	968.1556



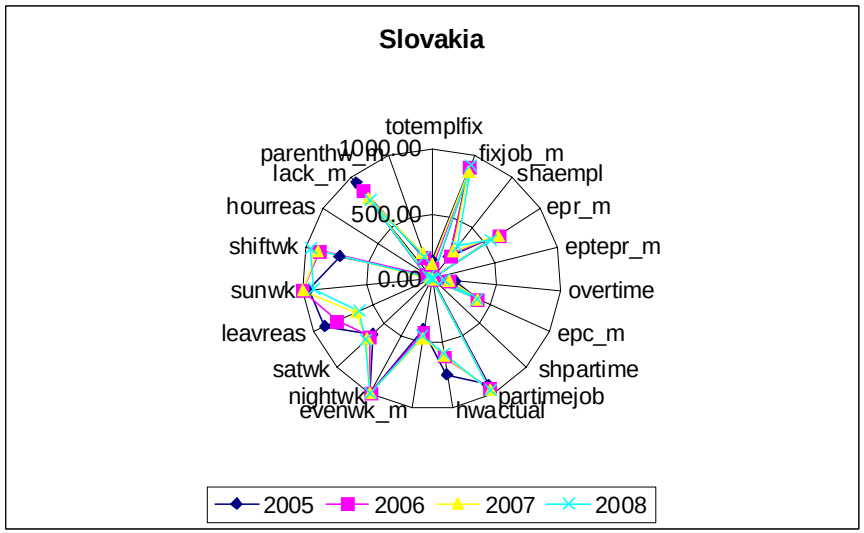
SE	2005	2006	2007	2008
totemplfix	272.10	248.46	284.21	590.5302
fixjob_m	809.14	822.85	793.16	837.8106
shaempl	129.66	133.66	154.44	174.7862
epr_m	435.21	435.21	435.21	435.2131
eptepr_m	306.06	306.06	306.06	122.653
overtime	1000.00	1000.00	1000.00	1000
epc_m	382.90	382.90	382.90	382.9
shpartime	303.76	319.34	294.27	313.3868
partimejob	10.00	120.98	86.24	59.89844
hwactual	219.50	246.75	254.35	262.8936
evenwk_m	275.95	280.06	332.20	312.4659
nightwk	202.17	244.67	331.57	329.8499
satwk	10.00	32.25	90.42	83.83774
leavreas	657.44	722.48	700.39	769.7727
sunwk	406.84	527.89	563.94	590.0158
shiftwk	634.31	693.51	720.42	708.0428
hourreas	695.16	710.83	636.62	769.7033
lack_m	1000.00	911.30	811.74	801.9335
parenthw_m	10.00	10.00	63.77	16.76091



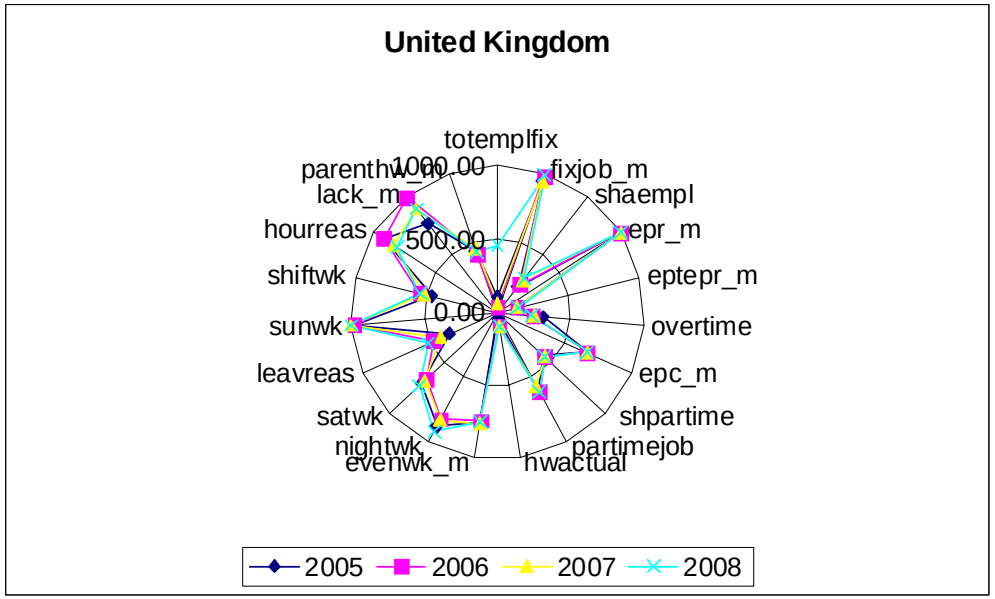
SI	2005	2006	2007	2008
totemplfix	485.03	443.36	526.69	291.0724
fixjob_m	723.27	739.20	666.22	755.3762
shaempl	116.59	173.68	189.76	163.8832
epr_m	341.08	341.08	341.08	341.082
eptepr_m	325.70	325.70	325.70	331.8588
overtime	499.81	515.77	477.11	369.8351
epc_m	670.00	670.00	670.00	670
shpartime	155.58	165.01	177.61	113.1808
partimejob	978.28	1000.00	1000.00	1000
hwactual	679.97	635.30	657.22	653.2787
evenwk_m	623.81	647.86	671.53	661.973
nightwk	787.24	756.88	783.93	859.3798
satwk	893.50	889.43	881.52	939.0239
leavreas	1000.00	1000.00	1000.00	758.0927
sunwk	845.61	874.50	906.70	864.1664
shiftwk	878.24	1000.00	1000.00	1000
hourreas	35.38	55.10	17.18	42.13157
lack_m	10.00	275.85	117.91	145.8452
parenthw_m	982.75	1000.00	1000.00	1000



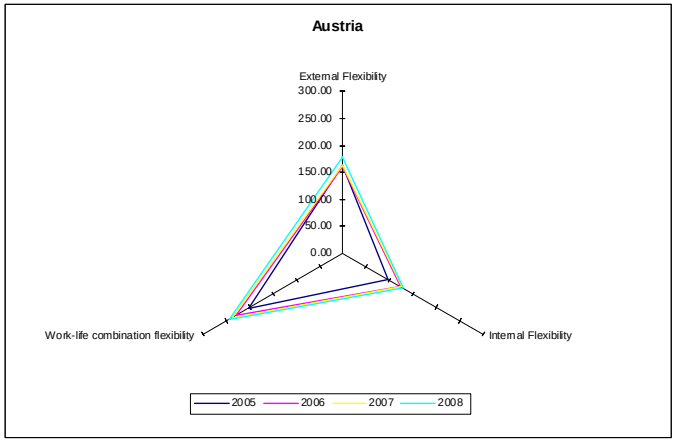
SK	2005	2006	2007	2008
totemplfix	147.08	84.26	121.52	14.77688
fixjob_m	872.84	905.37	871.89	923.8949
shaempl	222.71	227.69	264.72	323.6661
epr_m	613.74	613.74	613.74	552.0656
eptepr_m	10.00	10.00	10.00	10
overtime	179.97	128.85	137.01	94.0445
epc_m	382.90	382.90	382.90	382.9
shpartime	10.00	10.00	10.00	10
partimejob	925.70	958.51	969.35	970.6886
hwactual	743.97	605.42	598.12	585.3648
evenwk_m	391.46	420.90	460.51	441.5796
nightwk	1000.00	1000.00	1000.00	1000
satwk	624.09	652.91	676.39	689.5223
leavreas	898.59	801.79	638.46	611.4282
sunwk	952.10	1000.00	994.21	908.6678
shiftwk	729.19	889.22	901.97	958.3057
hourreas	46.95	52.76	15.75	33.42687
lack_m	944.21	863.57	787.71	768.8613
parenthw_m	167.00	177.62	207.91	175.6428



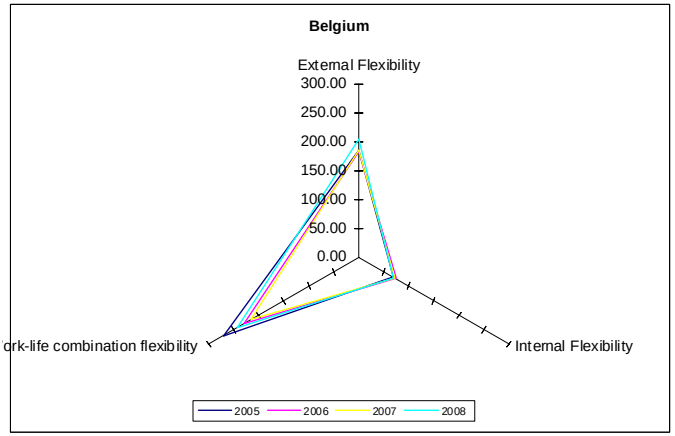
UK	2005	2006	2007	2008
totemplfix	106.85	37.39	65.63	454.6275
fixjob_m	950.05	976.98	945.25	989.8437
shaempl	230.16	246.90	279.59	296.4924
epr_m	1000.00	1000.00	1000.00	1000
eptepr_m	137.63	137.63	137.63	145.5128
overtime	309.91	243.12	250.25	230.3878
epc_m	670.00	670.00	670.00	670
shpartime	434.45	438.15	436.51	439.1589
partimejob	603.37	613.43	563.78	612.3914
hwactual	42.88	91.87	97.97	98.04678
evenwk_m	756.92	747.80	765.53	756.3261
nightwk	878.59	819.64	830.83	918.4194
satwk	705.95	665.75	677.55	730.4368
leavreas	357.31	479.14	420.51	514.4424
sunwk	978.33	979.43	1000.00	1000
shiftwk	462.45	543.92	510.88	545.3383
hourreas	914.29	925.41	840.93	814.4495
lack_m	766.43	1000.00	894.80	896.3244
parenthw_m	446.30	424.76	455.50	437.8192



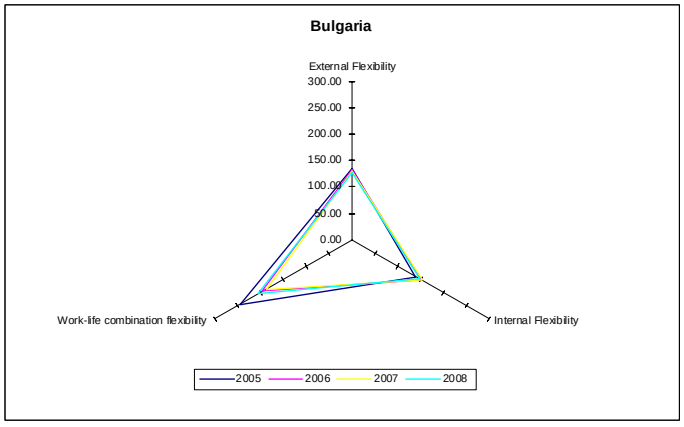
AT	2005	2006	2007	2008
External Flexibility	162.58	161.17	161.78	179.54
Internal Flexibility	96.84	123.04	125.04	130.14
Work-life combination flexibility	202.31	229.81	238.35	245.64



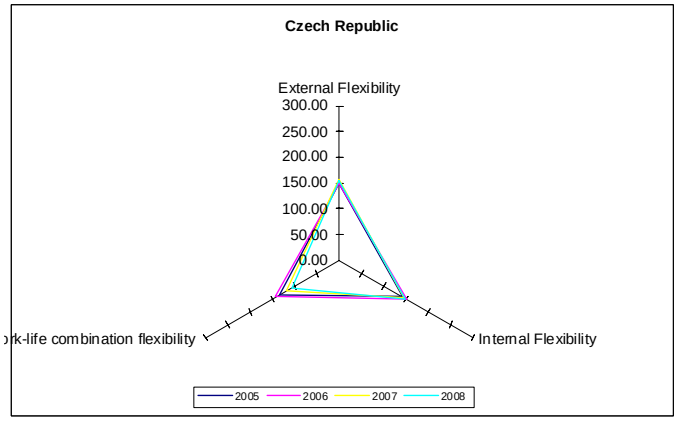
BE	2005	2006	2007	2008
External Flexibility	184.92	183.59	185.04	205.15
Internal Flexibility	68.57	73.55	73.15	69.79
Work-life combination flexibility	271.12	228.46	214.95	243.45



BG	2005	2006	2007	2008
External Flexibility	134.16	131.11	130.46	127.86
Internal Flexibility	139.22	151.14	152.01	147.26
Work-life combination flexibility	244.46	195.56	187.16	203.72

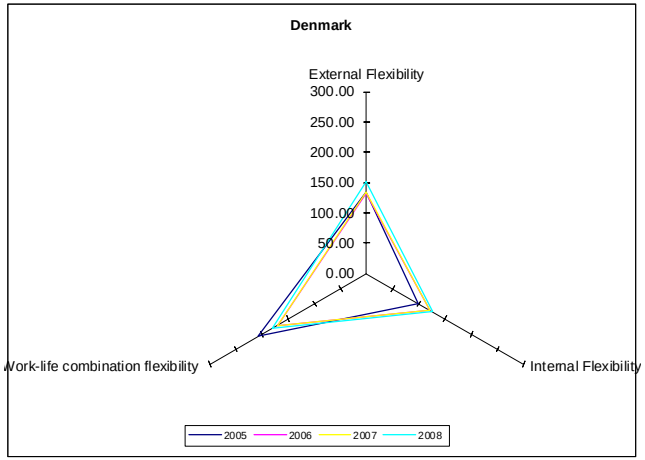


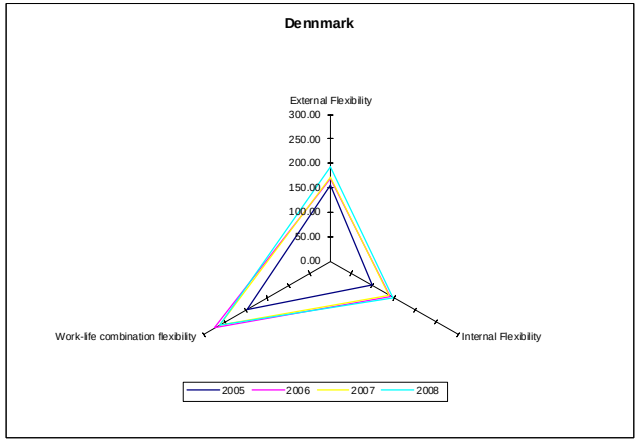
CZ	2005	2006	2007	2008
External Flexibility	149.53	148.77	156.39	153.79
Internal Flexibility	140.74	152.16	144.55	148.89
Work-life combination flexibility	135.47	142.54	117.61	105.58



DE	2005	2006	2007	2008
External Flexibility	135.15	132.64	134.14	151.62
Internal Flexibility	98.66	121.46	121.31	125.69
Work-life combination flexibility	206.50	170.70	170.68	180.17

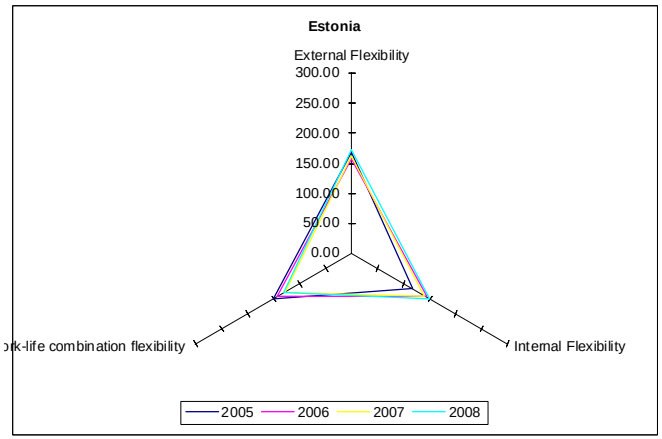
DK	2005	2006	2007	2008
External Flexibility	156.15	168.28	171.37	194.30
Internal Flexibility	96.65	142.94	139.50	147.81
Work-life combination flexibility	197.86	274.25	260.66	262.06

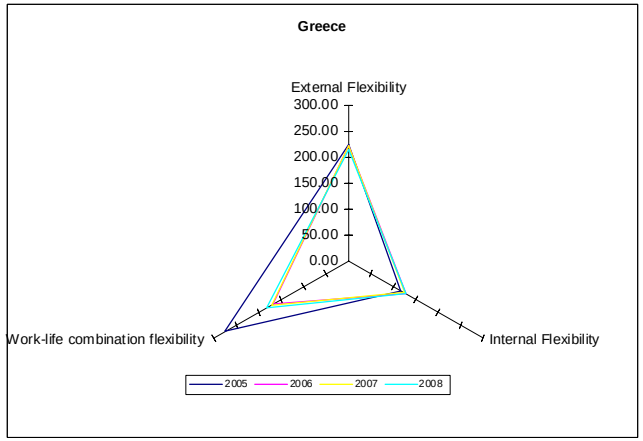




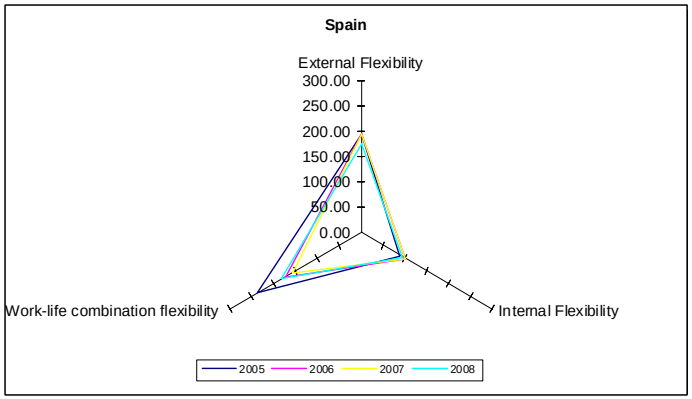
EE	2005	2006	2007	2008
External Flexibility	168.15	158.71	161.84	172.81
Internal Flexibility	116.26	143.86	140.79	148.94
Work-life combination flexibility	151.18	142.71	127.27	129.12

EL	2005	2006	2007	2008
External Flexibility	223.62	222.47	222.35	214.45
Internal Flexibility	117.02	126.68	123.81	129.13
Work-life combination flexibility	274.16	168.83	170.65	183.36

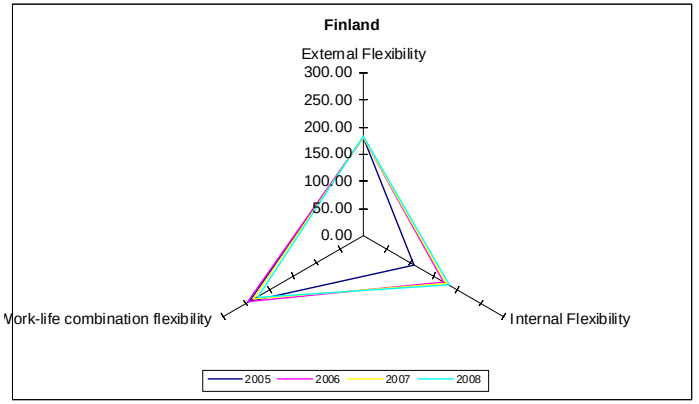




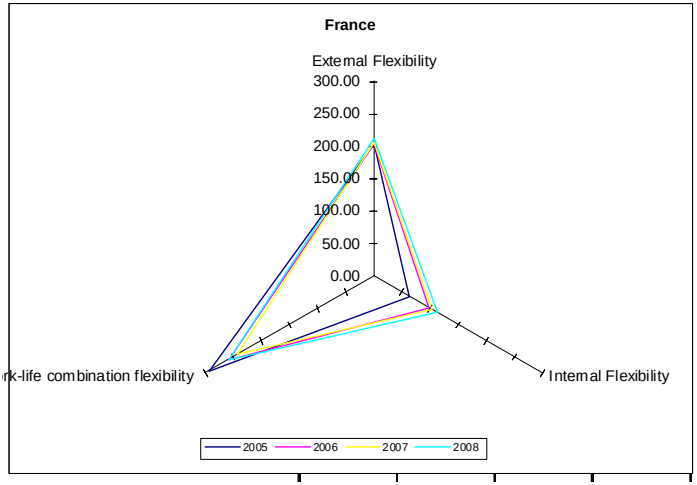
ES	2005	2006	2007	2008
External Flexibility	194.00	194.21	195.67	175.22
Internal Flexibility	88.80	101.51	99.62	95.34
Work-life combination flexibility	236.13	172.01	157.14	181.83



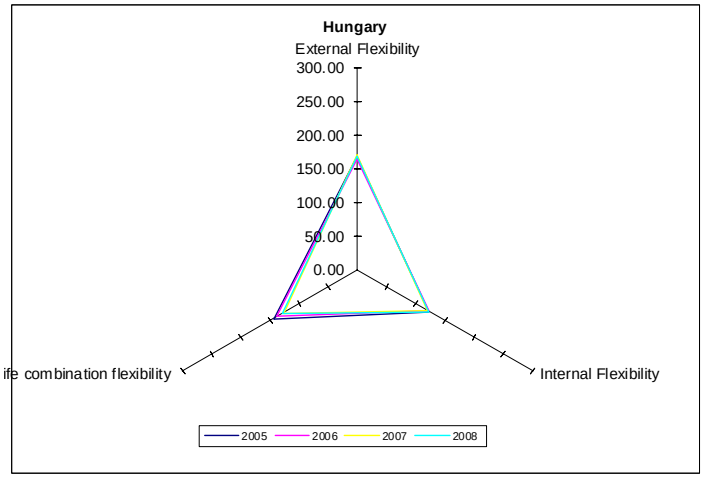
FI	2005	2006	2007	2008
External Flexibility	179.68	180.18	180.74	184.11
Internal Flexibility	108.24	172.27	175.77	182.85
Work-life combination flexibility	244.36	245.85	233.04	226.85



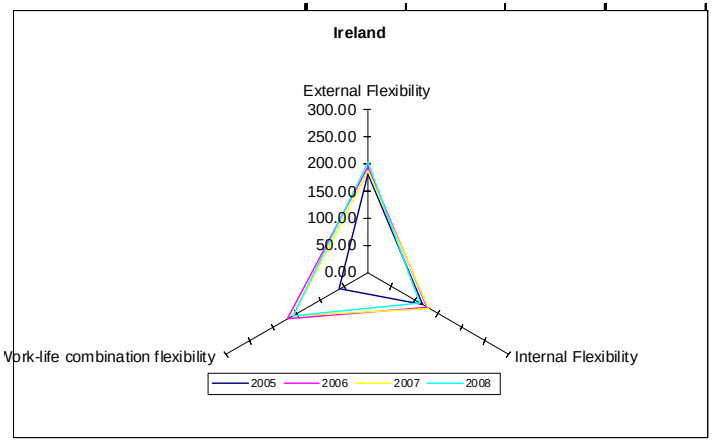
FR	2005	2006	2007	2008
External Flexibility	204.31	204.14	205.56	212.36
Internal Flexibility	64.54	98.19	104.44	113.06
Work-life combination flexibility	292.85	257.39	242.73	258.61



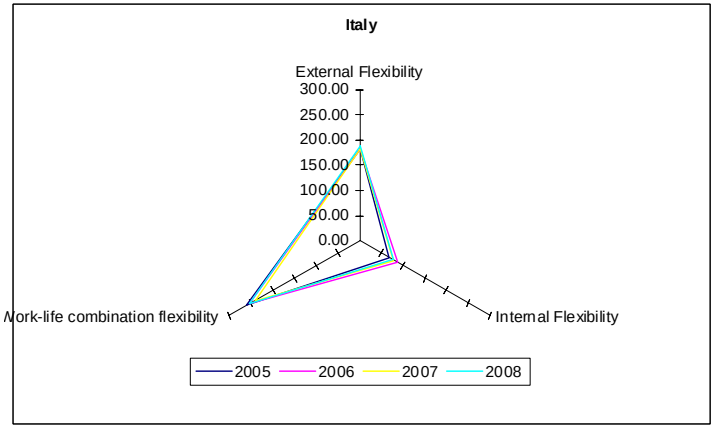
HU	2005	2006	2007	2008
External Flexibility	168.32	164.95	171.55	168.72
Internal Flexibility	123.24	122.28	121.34	123.05
Work-life combination flexibility	144.48	138.44	126.79	129.14



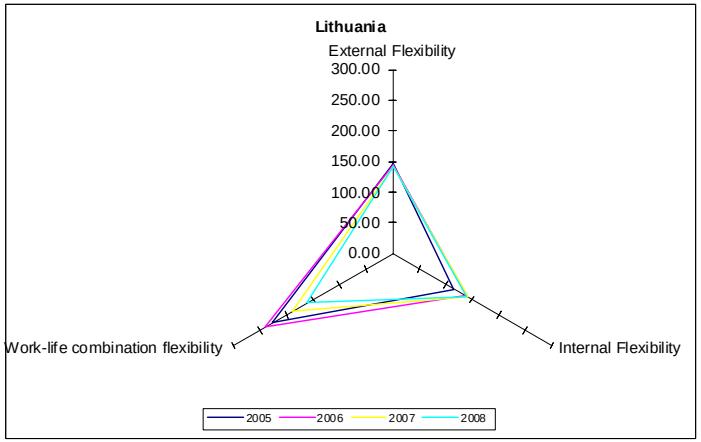
IE	2005	2006	2007	2008
External Flexibility	180.96	195.36	187.17	202.83
Internal Flexibility	116.91	125.54	130.50	113.16
Work-life combination flexibility	59.48	168.85	157.97	158.74



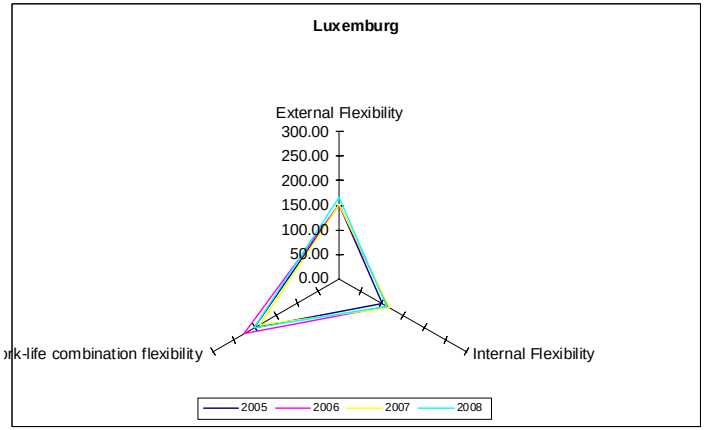
IT	2005	2006	2007	2008
External Flexibility	183.90	183.46	183.62	187.70
Internal Flexibility	68.59	88.25	79.62	77.44
Work-life combination flexibility	259.31	254.03	239.64	252.91



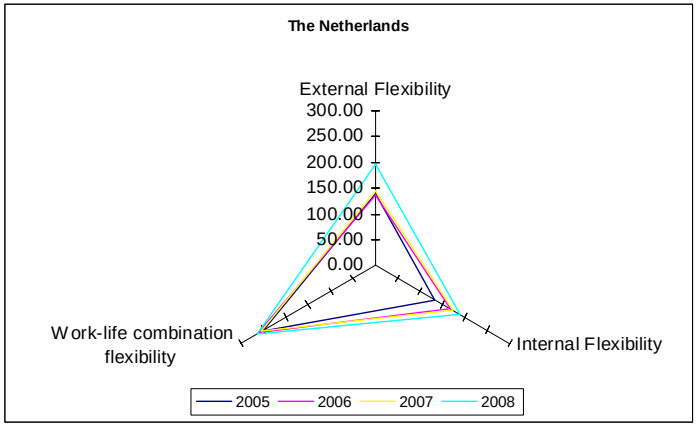
LT	2005	2006	2007	2008
External Flexibility	146.74	143.87	141.92	141.88
Internal Flexibility	115.62	138.53	140.94	140.82
Work-life combination flexibility	226.78	239.76	188.31	161.26



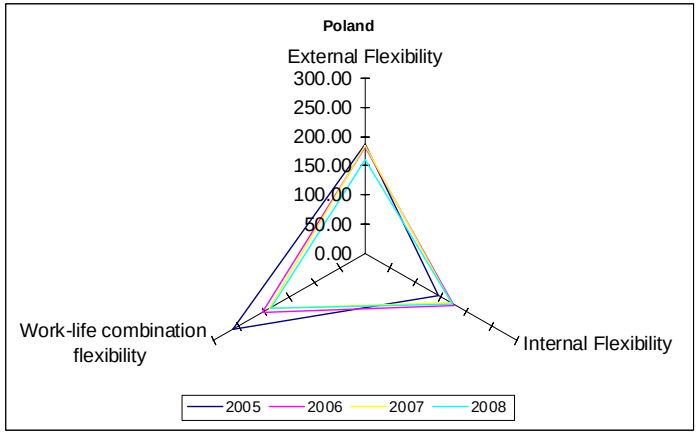
LU	2005	2006	2007	2008
External Flexibility	152.90	152.97	151.11	166.27
Internal Flexibility	101.19	115.67	116.55	112.13
Work-life combination flexibility	202.59	227.08	190.27	201.01



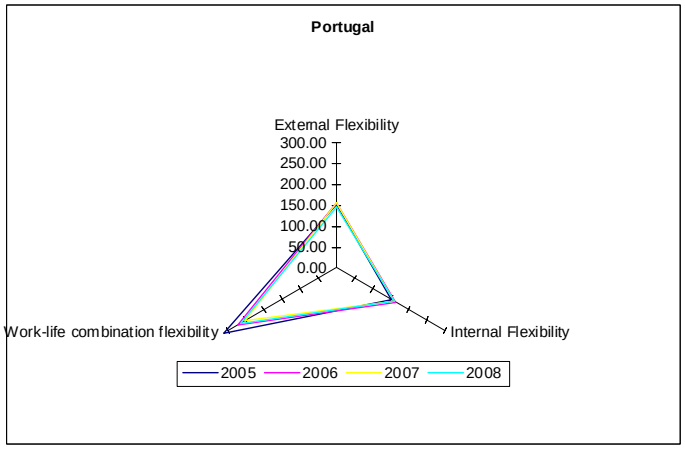
NL	2005	2006	2007	2008
External Flexibility	137.88	137.42	145.23	196.99
Internal Flexibility	132.93	167.95	172.25	189.77
Work-life combination flexibility	252.10	260.30	253.46	264.41



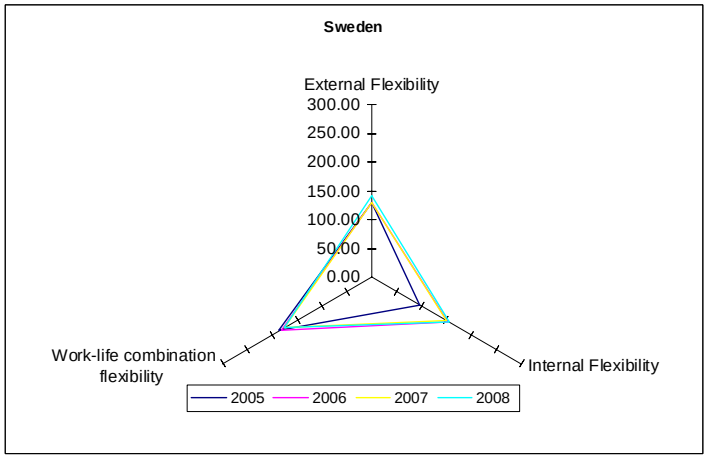
PL	2005	2006	2007	2008
External Flexibility	186.26	182.71	184.23	159.45
Internal Flexibility	144.12	176.65	171.02	171.76
Work-life combination flexibility	262.56	204.55	188.37	186.32



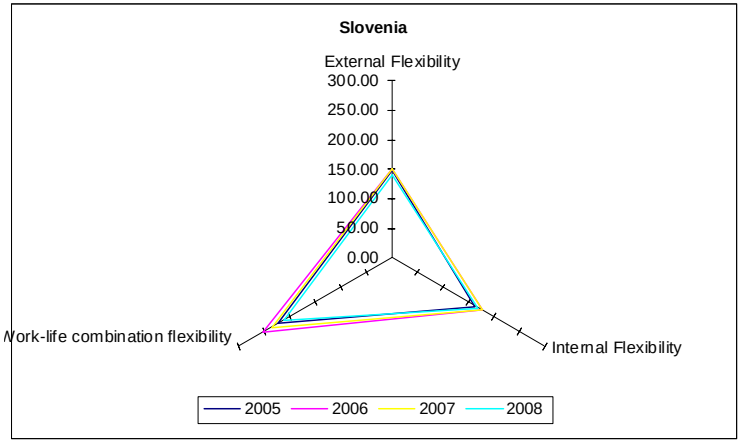
PT	2005	2006	2007	2008
External Flexibility	153.73	155.02	156.31	147.21
Internal Flexibility	153.47	165.07	158.96	160.12
Work-life combination flexibility	311.35	270.97	252.29	264.09



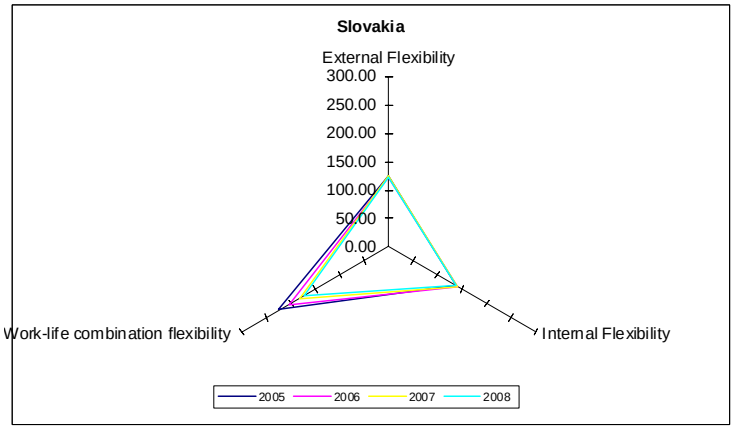
SE	2005	2006	2007	2008
External Flexibility	129.73	129.40	130.89	141.33
Internal Flexibility	95.12	152.98	148.84	156.15
Work-life combination flexibility	185.27	182.64	175.10	176.50



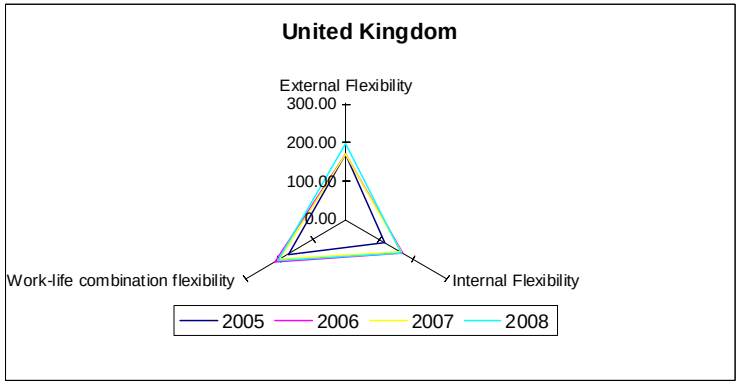
SI	2005	2006	2007	2008
External Flexibility	147.87	149.61	151.08	141.85
Internal Flexibility	163.54	178.05	176.55	169.07
Work-life combination flexibility	221.42	252.87	235.32	211.55



SK	2005	2006	2007	2008
External Flexibility	124.96	123.55	125.82	122.63
Internal Flexibility	136.29	141.56	140.94	138.51
Work-life combination flexibility	223.31	204.78	181.56	172.88



UK	2005	2006	2007	2008
External Flexibility	171.93	170.49	172.12	197.58
Internal Flexibility	114.14	170.18	163.69	165.81
Work-life combination flexibility	174.45	211.54	196.76	205.40



ANNEX 2: UNCERTAINTY AND SENSITIVITY ANALYSIS

Composite indicators may send misleading, non-robust policy messages if they are poorly constructed or misinterpreted. In fact, the construction of composite indicators involves stages where judgment has to be made: the selection of sub-indicators, the choice of a conceptual model, the weighting of indicators, the treatment of missing values etc. All these sources of subjective judgment will affect the message brought by the CI's in a way that deserve analysis and corroboration. A combination of uncertainty and sensitivity analysis can help to gauge the robustness of the composite indicator, to increase its transparency and to help framing a debate around it.

General procedures to assess uncertainty in the MSS composite indicators building are in this section applied and analyzed. In particular, five main sources of uncertainty can be highlighted and their combined effect on country rankings needs to be tested:

1) Data Normalization
2) Weighting Scheme
3) Composite Indicator Formula (Aggregation Rule)
4) Inclusion/Exclusion of Basic Indicators
5) Imputation of Missing Data via MCMC.

Two combined tools are suggested to assess the uncertainty in the FCA Composite Indicator: Uncertainty Analysis (UA) and Sensitivity Analysis (SA). UA focuses on how uncertainty in the input factors propagates through the structure of the composite indicator and affects the composite indicator values. SA studies how much each individual source of uncertainty contributes to the output variance.

In the field of building composite indicators, UA is more often adopted than SA (Jamison and Sandbu, 2001; Freudenberg, 2003) and the two types of analysis are almost always treated separately. A synergistic use of UA and SA is proposed and presented here, considerably extending earlier attempts in this direction (Tarantola et al., 2000).

With reference to the uncertainty sources (1 to 5 above), the approach taken to propagate uncertainties could include in theory all of the steps below:

1) Inclusion-Exclusion of basic indicators
2) Using alternative data normalization schemes, such as rescaling, standardization, use of raw data.
3) Using several weighting schemes, i.e. Equal Weights, predetermined set of weights, Principal Components weights, Data envelopment analysis weights.
4) Using several aggregation systems, i.e. linear, another based on geometric mean of un-scaled variable.
5) Testing different set of missing data randomly simulated

General Framework of the Analysis

As described above, we shall frame the analysis as a single Monte Carlo experiment, e.g. by plugging all uncertainty sources simultaneously, as to capture all possible synergistic effects among uncertain input factors. This will involve the use of triggers, e.g. the use of uncertain input factors used to decide e.g. which aggregation system and weighting scheme to adopt. To stay with the example, a discrete uncertain factor which can take integer values between 1 and 3 will be used to decide upon the aggregation system and another also varying in the same range for the weighting scheme. Other trigger factors will be generated to select which indicators to omit, the aggregation rule, the normalization scheme and so on. Below, the sources of uncertainty affecting the FCA composite indicator are analyzed.

Inclusion – exclusion of individual sub- indicators

No more than one indicator at a time is excluded for simplicity. A single random variable is used to decide if any indicator will be omitted and which one. Note that an indicator can also be practically neglected as a result of the weight assignment procedure. Although this is not the case of the FCA composite indicator, for instance imagine a very low weight is assigned by an expert to a sub-indicator q . Every time we select that expert in a run of the Monte Carlo simulation, the relative sub-indicator q will be almost neglected for that run.

Normalization

As described in (Nardo et al. 2005) several methods are available to normalise sub-indicators. The methods that are most frequently met in the literature are based on the re-scaled values or on the standardized values or on the raw indicator values. In the robustness assessment of the MSS composite indicator the Z-score standardization, the Min-Max standardization and the Ranking-based standardization are applied. These three methods are shortly described below.

The Min-Max Standardization

The basic standardization technique that has been applied is the Min-Max approach. Each indicator, q, was standardized based on the following rule:

$$I^{t}{}_{qc} = \frac{x^{t}{}_{qc} - \min_{c}(x_{q}^{2005-2008})}{\max_{c}(x_{q}^{2005-2008}) - \min_{c}(x_{q}^{2005-2008})} \cdot 1000 \quad .$$

Using this method, all indicators have been rescaled in such a way as to lie between 0 (laggard $x_{qc}=\min_c(x^{2005\text{-}2008}{}_q)$) and 1000 (leader, $x_{qc}=\max_c(x^{2005\text{-}2008}{}_q)$).

Where $\max_c(x^{2005\text{-}2008}_q)$ and $\min_c(x^{2005\text{-}2008}_q)$ are respectively the maximum and the minimum value of the indicator over all countries and years considered.

Standardisation (or Z-scores)

For each sub-indicator $x_{qc}^{2005-2008}$, the average across countries $\bar{x}_{qc}^{2005-2008}$ and the standard deviation across countries $\sigma_{x_{qc}}^{2005-2008}$ are calculated. The normalization formula is:

$$I_{qc}^{2005-2008} = \frac{x_{qc}^{2005-2008} - \bar{x}_{qc}^{2005-2008}}{\sigma_{x_{qc}}^{2005-2008}},$$

So that all the y_{mn} have similar dispersion across countries. This approach converts all indicators to a common scale with an average of zero and standard deviation of one, yet the actual minima and maxima of the standardized values across countries vary among the sub-indicators.

Ranking of indicators across countries

The simplest normalization method consists in ranking each indicator across countries. The main advantages of this approach are its simplicity and the independence to outliers. Disadvantages are the loss of information on absolute levels and the impossibility to draw any conclusion about difference in performance.

$$I_{qc}^{2005-2008} = Rank(x_{qc}^{2005-2008})$$

Weighting Scheme

Central to the construction of a composite index is the need to combine in a meaningful way different dimensions measured on different scales. This implies a decision on which weighting model will be used and which procedure will be applied to aggregate the information.

Addressing the reader to (Nardo et al. 2005) for an exhaustive list of weighting schemes, in the robustness analysis of MSS composite indicator, three different weighting schemes are adopted and described below.

Equal Weights

In many composite indicators all variables are given the same weight when there are no statistical or empirical grounds for choosing a different scheme. Equal weighting (EW) could imply the recognition of an equal status for all sub-indicators (e.g. when policy assessments are involved).

Alternatively, it could be the result of insufficient knowledge of causal relationships, or ignorance about the correct model to apply (like in the case of Environmental Sustainability Index – World economic forum, 2002), or even

stem from the lack of consensus on alternative solutions (as happened with the Summary Innovation Index - European Commission, 2001a). In any case, EW does not mean any weighting, because EW anyway implies an implicit judgment on the weights being equal. The effect of EW also depends on how component indicators are divided into categories or groups: weighting equally categories regrouping a different number of sub-indicator could disguise different weights applied to each single sub-indicator.

Factor Analysis Weights

Principal component analysis (PCA) and more specifically factor analysis (FA) group together sub-indicators that are collinear to form a composite indicator capable of capturing as much of common information of those sub-indicators as possible. The information must be comparable for this approach to be used: sub-indicators must have the same unit of measurement. Each factor (usually estimated using principal components analysis) reveals the set of indicators having the highest association with it. The idea under PCA/FA is to account for the highest possible variation in the indicators set using the smallest possible number of factors. Therefore, the composite no longer depends upon the dimensionality of the dataset but it is rather based on the "statistical" dimensions of the data. According to PCA/FA, weighting only intervenes to correct for the overlapping information of two or more correlated indicators, and it is not a measure of importance of the associated indicator. If no correlation between indicators is found, then weights can not be obtained estimated with this method. For methodological details we address the reader to (Nardo et al. 2005).

Data Envelopment Analysis, (DEA), Weights

Data envelopment analysis (DEA) employs linear programming tools (popular in Operative Research) to retrieve an efficiency frontier and uses this as benchmark to measure the performance of a given set of countries.17 The set of weighs stems from this comparison. Two main issues are involved in this methodology: the construction of a benchmark (the frontier) and the measurement of the distance between countries in a multi-dimensional framework.

The construction of the benchmark is done by some simple assumptions as: positive weights (the higher the value of one sub-indicator, the better for the corresponding country); non discrimination of countries that are best in any single dimension (i.e. sub indicator) thus ranking them equally; a linear combination of the best performers is feasible (convexity of the frontier). The distance of each country with respect to the benchmark is determined by the location of the country and its position relative to the frontier. The countries supporting the frontier are classified as the best performing, other countries are then ordered according to the distance with respect to the benchmark. For methodological details we address the reader to (Nardo et al. 2005).

The benchmark could also be determined by a hypothetical decision maker (Korhonen et al. 2001, for an indicator of performance of academic research) who is asked to locate the target in the efficiency frontier having the most preferred combination of sub-indicators. In this case the DEA approach could merge with the budget allocation method (see below) since experts are asked to assign weights (i.e. priorities) to sub-indicators.

Aggregation Rules

The literature of composite indicators offers several examples of aggregation techniques. The most used are additive techniques that range from summing up country ranking in each sub indicator to aggregating weighted transformations of the original sub-indicators. However, additive aggregations imply requirements and properties, both of component sub-indicators and of the associated weights, which are often not desirable, at times difficult to meet or burdensome to verify. To overcome these difficulties the literature proposes other and less widespread, aggregation methods like multiplicative (or geometric) aggregations or non linear aggregations like the multi-criteria or the cluster analysis. For the MSS composite indicator we focus our attention on additive methods and geometric aggregation.

Additive methods

The simplest additive aggregation method entails the calculation of the ranking of each country according to each sub-indicator and the summation of resulting ranking (e.g. Information and Communication Technologies Index - Fagerberg J. 2001). By far the most widespread linear aggregation is the summation of weighted and normalized sub-indicators:

$$Y_c^t = \sum_{i=1}^{3} w_i \sum_{j=1}^{k_i} w_j^* I_{ijc}^t$$

Where t is the year of reference, w are the weights of the 3 dimensions, w^* are the weights of basic indicators within each dimension, I the basic indicators and c the country index.

Geometric aggregation

An undesirable feature of additive aggregations is the full compensability they imply: poor performance in some indicators can be compensated by sufficiently high values of other indicators. For example if a hypothetical composite were formed by inequality, environmental degradation, GDP per capita and unemployment, two countries, one with values 21, 1, 1, 1; and the other with 6,6,6,6 would have equal composite if the aggregation is additive. Obviously the two countries would represent very different social conditions that would not be reflected in the composite.

If multicriteria analysis entails full non-compensability, the use of a geometric aggregation (also called deprivational index) is an in-between solution.

$$Y_c^t = \prod_{i=1}^{3} \prod_{j=1}^{k} I_{ijc}^{t\ w_i w_j^*}$$

Where *t* is the year of reference, *w* are the weights of the 3 dimensions, w^* are the weights of basic indicators within each dimension, *I* the basic indicators and *c* the country index.

Uncertainty Analysis

All points showed above chain of composite indicator building can introduce uncertainty in the output variables Rank(I^t_c). Thus we shall translate all these uncertainties into a set of scalar input factors, to be sampled from their distributions. As a result, all outputs Rank(I^t_c) are non-linear functions of the uncertain input factors, and the estimation of the probability distribution functions (pdf) of Rank(I^t_c) is the purpose of the uncertainty analysis. The UA procedure is essentially based on simulations that are carried on the various equations that constitute our model. As the model is in fact a computer programme that implements different scenarios, the uncertainty analysis acts on a computational model. Various methods are available for evaluating output uncertainty.

In the following, the Monte Carlo approach is applied, which is based on performing multiple evaluations of the model with k randomly selected model input factors. The procedure involves different steps and we address the reader to (Nardo et al, 2005, Saltelli et al. 2000a, Saltelli et al. 2000b, Saltelli, A. 2002, Saltelli et al. 2008).

The selected random factors for which the uncertainty is assessed to the FCA composite indicator are four and are listed below in table 16:

Table 16 - Uncertainty factors for the FCA composite indicator

X_1	Standardization
1	Z-Score
2	Min-Max

X_2	Weighting Scheme
1	Equal Weight
2	Predetermined set of Weights

X_3	Aggregation Rule
1	Linear

X_4	Excluded Sub-Indicator
1	Indicator 1 omitted
2	Indicator 2 omitted
3	Indicator 3 omitted
...	...
19	Indicator 19 omitted

X_5	Imputation of Missing Data via MCMC
1	Sample 1 of the set of missing data randomly simulated.
2	Sample 2 of the set of missing data randomly simulated.
3	Sample 3 of the set of missing data randomly simulated.
…	…
100	Sample 100 of the set of missing data randomly simulated..

Where, trigger X_1 is used to select the standardization methods (Z-score, Min-Max, Ranking of Indicators across countries), trigger X_2 is used to select the weighting scheme (Equal weights, Predetermined set of weights).Then trigger X_3 is used to select the aggregation rule (linear/additive, geometric). Trigger X_4 is generated to select which sub-indicator –if any, should be omitted. Finally, trigger X_5 is used to sample 100 set of missing data randomly simulated. Each input factor can be characterized by a probability density function; here we assume uniform distribution for the entire five input factors in order to do not penalize/reward any possible trigger modality.

After having generated the input factors distributions in step 1, we can now generate randomly N combinations of independent input factors X^i, i= l, 2 ,…,N where X^i is a set of outcomes of input factors, called a sample. For each trial sample $X^{l\backslash i}$ the computational model can be evaluated, generating values for the scalar output variable Y_l, where Y_l is the Rank(I^t_c) , the value of the rank assigned by the composite indicator to each country.

In the case of the uncertainty analysis of the FCA composite indicator the total number of simulations performed is set equal to 12000, which correspond to the total exploration of all the possible combinations of the input factors.

The results of the uncertainty analysis are presented below. For every country the results of the distribution of the scores of the 12000simulations are presented. The results of the simulations are organized in a frequency matrix and the overall FCA is calculated across the 12000scenarios. Besides the frequency matrix, the median rank per country was selected in order to compare with the rank recorded in the FCA composite indicator.

On figures 3-7 the frequency distribution in all three years for all countries rank is presented. The frequencies of the FCA indicator 2005-2008 are estimated over the 12000 different scenarios. On table 18 an example of frequency distribution of a country rank over the 12000 scenarios is presented. A colour code is used to distinguish different frequencies as illustrated in table 17:

Table 17 - Colour Codes

	Frequency lower than 10%
	Frequency between 10% and 20%
	Frequency between 20% and 35%
	Frequency between 35% and 50%
	Frequency higher than 50%
bold	Position in the FCA composite indicator
Italic	median
Red	mode of the distribution

Moreover, **Bold**, *Italic* and Red represent the country rank in the MSS composite indicator, the median and the mode of the 12000 simulations, respectively. For example Sweden in 2005 has a distribution encoded as follows in table 18:

Table 18 – Frequencies of Sweden performance in the 29400 scenarios in 2005.

	1	2	3	4	5
FI	8.08%	25.30%	*24.25%*	20.37%	**18.01%**

This means that the country is ranked in positions 1st to 5th among the 12000 simulations performed. In particular, Finland is ranked in position 1st with a frequency lower than 10%, in position 2nd to 3rd with a frequency between 20% and 35%, in position 5th with a frequency between 10% and 20%. Position 2nd is the mode, the median falls in the 3rd position the country in the composite indicator.

In the following tables, the frequency matrices for the period 2005-2008 are presented. Due to the huge number of simulations performed, only frequencies higher than 10% are shown. A first consideration is that the overall ranking is quite stable; in fact, considering the main indicator, over the whole set of 12000 simulations all countries clustered unambiguously. This is true in particular for the first and the last positions which show a very low degree of variability across the three years. The imputation of missing data

affects the results of the uncertainty analysis only to a minor extent. In this section a general overview of the results of uncertainty analysis is given, whereas the specific situation of each country is commented in the country profile section.

The frequency matrix for 2005 is shown in Figure 3. Although the results of uncertainty analysis for this year show some variability in the ranking of countries, the overall situation does not contradict the ranking of the composite indicator presented in table 2. In particular, Portugal is the leader of the ranking in the 30% of the 12000 different scenarios performed. A similar situation holds for Greece which is ranked in the top 3 positions in 70% of the cases. The ranking of Poland is quite robust, the country ranks in the first 3rd positions in more than 90% of the cases. France presents a high variability in the ranking which goes from the 3rd to the 6th position, the mode falls in the 5th position in almost 34% of the cases, whereas the position of the composite indicator falls in the 4th. Finland presents a variability in the ranking which goes from the 1st to the 5th position with the median of the distribution in 3rd and the position of the indicator in 5th. The Netherlands, Slovenia and Spain present a high variability in the position of the country respect the 12000 scenarios, the Netherland ranks between the 6th and the 8th positions in 60% out of 12000 different scenarios, Slovenia falls between the 7th and the 8th position in 255 of the cases while Spain ranks between the 6th ad 8th position in 34% of the cases. Apart these cases, for most countries ranking is robust and it is concentrated in their position in the index in general on 50% of scenarios considered.

Results for 2006 highlight some increase in the variability of countries' ranking although the overall situation does not contradict the composite indicator presented above. Despite the increase in variability, for most countries record a rank which varies across a maximum of +/- 2 positions compared with that identified in the composite indicator. This trend is confirmed in more than 90% of the 12000 different scenarios considered. Moreover, results are still robust even if ranking position of the countries in many cases is recorded between 40% and 80% of all possible scenarios computed. A particular case is Ireland which presents the highest variability in the ranking across all the 12000 different scenarios implying that some assumptions in the possible sources of uncertainty can affect the country ranking in some cases. For some countries, such as United Kingdom, Italy, Austria, or Belgium the ranks varies within 3 positions in more than 55% of the different scenarios. Other countries present a bi-modal distribution, such as Germany or Bulgaria, but in both cases the median of the distribution corresponds to the position recorded in the composite indicator.

The uncertainty analysis results for 2007, despite presenting a slight increase in the variability of countries' ranking, confirms for most of them the positions of the composite indicator. This is not the case for Portugal, which ranks from the 3rd to the 9th position in 50% of the cases, or Poland which ranks from the 2nd to the 9th position in 70% of the cases. Three other countries present a similar situation: Denmark, The Netherlands and Slovenia which respectively rank between the 2nd and 6th position in 75% of cases, between the 2nd and 6th in 60% of cases and between the 4th and 9th in 60% of cases. This ranking variability is mainly due to the weak correlations within the basic indicators. However, most countries record a ranking which does not deviate more than +/- 3

positions relative to the one in the composite indicator. In particular, Greece moves across the 10th and 12th position in more than 55% of cases. Germany, Czech Republic and Hungary have their ranking varying by three positions in more than 70% of cases. Spain, Italy and Slovakia show a bi-modal distribution of the frequencies, but in all the cases the median of the distribution corresponds to the position recorded in the composite indicator.

Figure 6 shows the results of the uncertainty analysis for the 2008 Flexible and Reliable Contractual Arrangement composite indicator. Although the results of uncertainty analysis for this year show some variability in the ranking of countries, for most of them the country positions of the composite indicator shown in table 12 are confirmed. For few countries the ranking position does not confirm the position of the composite indicator such as for France which ranks from the 4th to the 6th position in 75% of the cases out of 12000 different scenarios simulated or as for Germany which ranks between the 16th and the 17th position with 35% of the observations. Similar situation is recorded for United Kingdom, Belgium, Italy, Poland, Estonia and Sweden where the variability in the ranking involved 4 different positions. This ranking variability in countries distributions is due mainly as a result of imputation of missing data and a lack of correlation in the structure of correlation among the basic indicators. Luxemburg, Bulgaria and Ireland present a bi-modal distribution of the frequencies, but in all the cases the median of the distribution corresponds to the position recorded in the composite indicator.
Moreover, results are still robust in some countries, such as Finland , which ranks the 1st position in 79% of the cases out of 12000 different scenarios simulated, Denmark where the rank varies within 2 positions in more than 60% of the different scenarios.

Figure 3 - Uncertainty Analysis frequency matrix for 2005

2005		PT	EL	PL	FR	FI	NL	SI	ES	BE	BG	IT	UK	LT	DK	SK	AT	DE	LU	EE	SE	CZ	HU	IE
Rank	1	**30.02%**	16.47%	37.55%	3.86%	8.08%																		
Rank	2	12.38%	**24.67%**	35.11%	0.90%	25.30%																		
Rank	3	9.28%	33.08%	**21.82%**	7.79%	24.25%																		
Rank	4	17.86%	18.28%		**26.26%**	20.37%																		
Rank	5	20.93%			33.54%	**18.01%**																		
Rank	6				19.53%		**34.36%**		13.25%															
Rank	7						26.68%	**13.66%**	11.18%	12.06%														
Rank	8						11.09%	11.88%	**8.64%**	25.41%	10.78%	11.26%												
Rank	9									**30.59%**	14.76%	17.26%	10.92%											
Rank	10									15.02%	**16.25%**	21.27%	14.34%											
Rank	11										14.58%	**16.23%**	16.17%	9.31%										
Rank	12										10.98%	9.58%	**16.63%**	15.33%	10.50%	8.88%								
Rank	13										7.22%		11.66%	**24.13%**	15.09%	9.08%								
Rank	14										10.22%		10.59%	18.76%	**17.39%**	8.68%	12.49%							
Rank	15													10.23%	17.77%	**11.70%**	16.10%	13.69%						
Rank	16														14.20%	11.33%	**11.18%**	17.69%						
Rank	17															12.28%		**24.63%**	12.02%	16.48%				
Rank	18																	11.50%	**14.30%**	33.83%	13.45%			
Rank	19																		12.92%	**23.27%**	11.69%	16.26%	14.29%	
Rank	20																		15.03%	9.15%	**14.70%**	11.53%	23.79%	
Rank	21																		9.33%		20.18%	**22.73%**	22.03%	9.37%
Rank	22																		24.48%		21.83%	23.61%	**18.34%**	5.11%
Rank	23																						9.73%	**79.20%**

Figure 4 - Uncertainty Analysis frequency matrix for 2006

2006		FI	PT	DK	SI	NL	PL	FR	UK	IT	LT	EL	AT	LU	IE	BE	BG	SK	ES	SE	EE	CZ	HU	DE
Rank	1	**69.54%**	14.20%		7.49%																			
Rank	2	16.29%	**16.91%**	16.96%	13.87%		27.70%																	
Rank	3	7.62%	10.78%	**21.01%**	28.53%		11.03%																	
Rank	4		11.73%	14.65%	**18.83%**		14.20%	6.18%																
Rank	5		7.69%	22.31%	12.70%	**19.48%**	10.92%	5.16%																
Rank	6		10.48%	11.74%		8.43%	**10.87%**	26.85%	11.85%															
Rank	7					17.67%	14.28%	**22.76%**	13.64%		7.00%													
Rank	8					14.92%		9.43%	**31.02%**	7.40%	11.98%													
Rank	9					10.04%		13.17%		**23.22%**	17.05%	5.88%	9.87%											
Rank	10					10.86%		5.90%		13.67%	**25.97%**	10.61%	13.35%											
Rank	11									29.91%	17.18%	**8.40%**	13.91%											
Rank	12									9.88%	11.05%	15.36%	**18.34%**		7.60%	15.98%								
Rank	13											8.38%	4.39%	**17.08%**	7.58%	30.22%			8.05%					
Rank	14											12.59%		13.52%	**5.26%**	26.28%	7.86%		9.88%					
Rank	15											7.89%		19.00%	5.94%	**7.64%**	20.71%	10.47%	10.23%					
Rank	16													9.96%	5.37%		**22.88%**	21.31%	10.80%	7.88%				
Rank	17													10.33%	8.91%		9.53%	**16.39%**	14.93%	17.23%				
Rank	18													9.46%	6.87%		6.64%	14.08%	**14.08%**	17.93%	5.51%	7.33%		
Rank	19														7.51%		10.66%	8.08%	10.78%	**17.53%**	11.26%	4.04%	10.80%	
Rank	20														4.73%		5.42%		5.13%	11.41%	**22.84%**	13.43%	11.40%	14.33%
Rank	21														3.48%		10.50%			7.62%	13.71%	**27.24%**	16.52%	8.77%
Rank	22														2.60%					8.97%	18.23%	19.41%	**26.71%**	14.00%
Rank	23														8.13%						20.80%	12.65%	25.88%	**19.09%**

Figure 5 - Uncertainty Analysis frequency matrix for 2007

2007		FI	DK	NL	PT	SI	FR	PL	UK	AT	EL	IT	IE	BE	LT	BG	LU	SE	ES	SK	EE	DE	HU	CZ
Rank	1	70.56%																						
Rank	2	13.84%	**13.91%**	22.68%				13.95%		12.57%														
Rank	3		18.40%	**16.12%**	11.64%			14.68%		15.68%														
Rank	4		14.35%	13.88%	**12.78%**	13.58%	19.55%	9.74%		5.06%														
Rank	5		22.00%	13.18%	4.33%	**19.63%**	15.33%	8.77%		2.35%														
Rank	6		14.32%	17.73%	6.97%	5.82%	**19.43%**	12.78%		10.04%														
Rank	7				9.53%	6.04%	14.58%	**20.33%**	17.13%	8.63%		12.28%												
Rank	8				5.94%	16.08%			**16.66%**	21.11%	4.62%	5.86%												
Rank	9				10.37%	12.15%			17.95%	**15.14%**	8.97%	9.93%												
Rank	10								18.08%	7.68%	23.57%	11.28%		7.28%										
Rank	11										13.18%	**37.32%**	10.11%	11.10%										
Rank	12										11.97%		**15.98%**	26.14%	14.77%									
Rank	13												10.78%	**34.11%**	15.95%	10.58%		10.56%						
Rank	14												9.08%	8.11%	**21.30%**	14.24%		11.54%	11.48%					
Rank	15												11.17%			**26.92%**	5.25%	11.68%	7.13%			8.14%	9.53%	
Rank	16															16.99%	**12.87%**	16.62%	5.58%			5.89%	6.24%	
Rank	17															12.36%	11.44%	**14.47%**	15.71%		8.14%	6.28%	5.91%	
Rank	18																17.59%		**17.84%**	11.80%	7.67%	4.51%	9.19%	
Rank	19																9.98%		9.78%	**19.53%**	8.40%	13.90%	6.83%	
Rank	20																5.73%			20.04%	**15.50%**	14.52%	8.52%	
Rank	21																16.63%			7.30%	14.25%	**20.10%**	13.70%	11.16%
Rank	22																			4.66%	18.79%	6.73%	**27.47%**	24.53%
Rank	23																			10.69%	22.47%	8.77%	9.29%	**36.58%**

Figure 6 - Uncertainty Analysis frequency matrix for 2008

2008		NL	DK	FI	FR	PT	UK	AT	EL	SI	BE	IT	PL	LU	BG	IE	SE	DE	ES	EE	LT	SK	HU	CZ
Rank	1	79.14%	2.56%	16.78%																				
Rank	2	12.18%	45.99%	12.33%		10.29%		12.63%																
Rank	3		21.90%	**33.71%**		9.18%	12.26%	11.13%																
Rank	4		12.48%	16.32%	**31.08%**	4.48%	13.88%	15.08%																
Rank	5				32.31%	**11.63%**	22.48%	10.74%																
Rank	6				16.58%	8.43%	**33.43%**	22.66%																
Rank	7					21.21%		**18.74%**					24.43%											
Rank	8					10.12%			**11.09%**	9.25%	19.95%	21.19%	13.99%											
Rank	9								9.88%	**13.49%**	24.38%	21.15%	14.03%											
Rank	10								9.81%	10.84%	**27.75%**	16.82%	17.33%											
Rank	11								12.22%	15.02%	10.09%	**17.93%**	13.97%			14.18%								
Rank	12								11.13%	29.80%	7.92%	9.42%	**9.59%**			9.62%		9.24%						
Rank	13								10.72%	12.20%				**11.30%**	15.85%	7.72%	11.14%	4.48%	17.10%					
Rank	14													11.90%	11.43%	11.03%	13.35%	9.93%	18.35%					
Rank	15													9.28%	8.83%	**15.30%**	21.58%	8.93%	7.52%					
Rank	16													9.52%	6.84%	8.89%	**17.12%**	19.44%	7.52%		10.73%			
Rank	17													5.04%	7.31%	9.13%	9.06%	**18.33%**	8.07%	14.86%	10.22%			
Rank	18													5.18%	6.70%	4.44%		9.42%	**15.21%**	12.02%	15.72%			
Rank	19													7.03%	8.57%	5.08%				**19.77%**	13.30%	14.74%		
Rank	20													7.01%	12.70%					10.50%	**23.42%**	11.52%		
Rank	21													9.60%	12.69%							**27.31%**	14.15%	
Rank	22													10.64%	5.54%							12.49%	**31.45%**	19.27%
Rank	23													9.94%	0.03%							16.88%	18.33%	**49.95%**

The overall variation in the position is synthesized for each year (figures 6-10). The width of the 5%-95% percentile bounds across the 12000 simulations represent the different rankings achieved by each country for the main indicator. Black marks correspond to the median FCA composite indicator rank and whiskers show best and worst rank occupied by a country considering the 12000 simulations. The confidence bound proved the stability and robustness of the ranking. In fact for instance in 2005 over the 12000 simulations only 2 countries shift more than 3 positions while most countries present only 1 shift position in the ranking. In 2005 11 countries, approximately the 47% of the total number of countries, do not shift position at all, while approximately the 40% of the total number of countries shift of 1 positions, in 2006 even if one country present a variability of 4 positions, approximately 52% of the total number of countries remain in the same position of the median. In 2007 70% of the countries confirm the ranking position of the indicator with the median position, and in 2008 only 3 countries present a variability of 3 positions.

In the relevant literature, the median rank is proposed as a summary measure of a rank distribution. The median rank of all combinations of assumptions indicates that for instance in 2005 for 11 out of 23 countries the FCA rank corresponds with the most likely (median) rank. Thus, for the remaining countries the differences between the FCA rank and the most likely (median) rank is less than 3 positions. So that, for all the countries studied in all the fourth years, the very modest sensitivity of the FCA ranking to the five input factors (standardization, weighting scheme, aggregation rule, inclusion/exclusion of a single indicator and missing imputation) implies a considerably degree of robustness of the index for all the countries. The comparison in all three years is shown from table 19 to table 22.

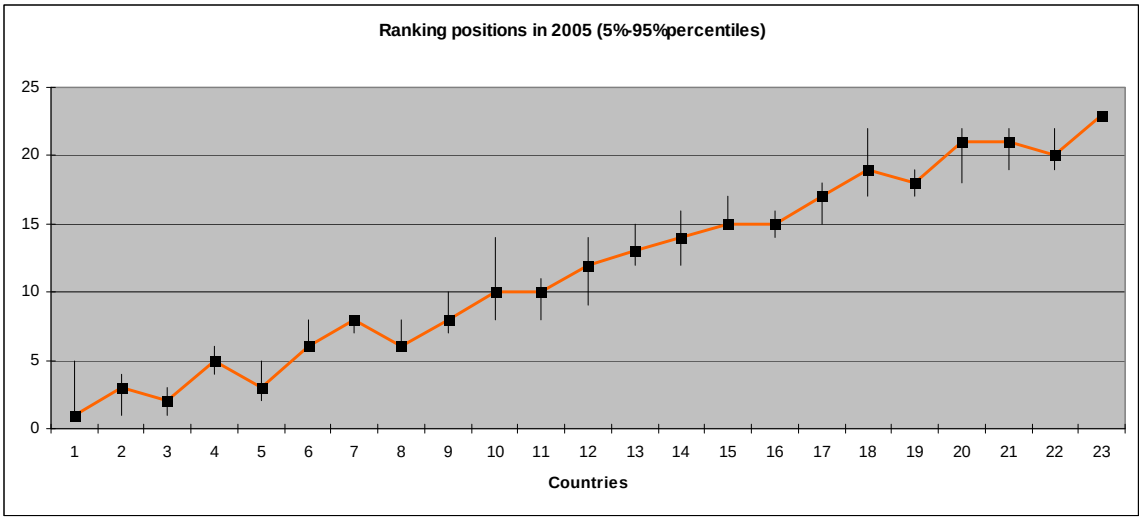


Figure 6 – Results of the Uncertainty Analysis: Ranking Position in 2005 (5%-95% percentiles)

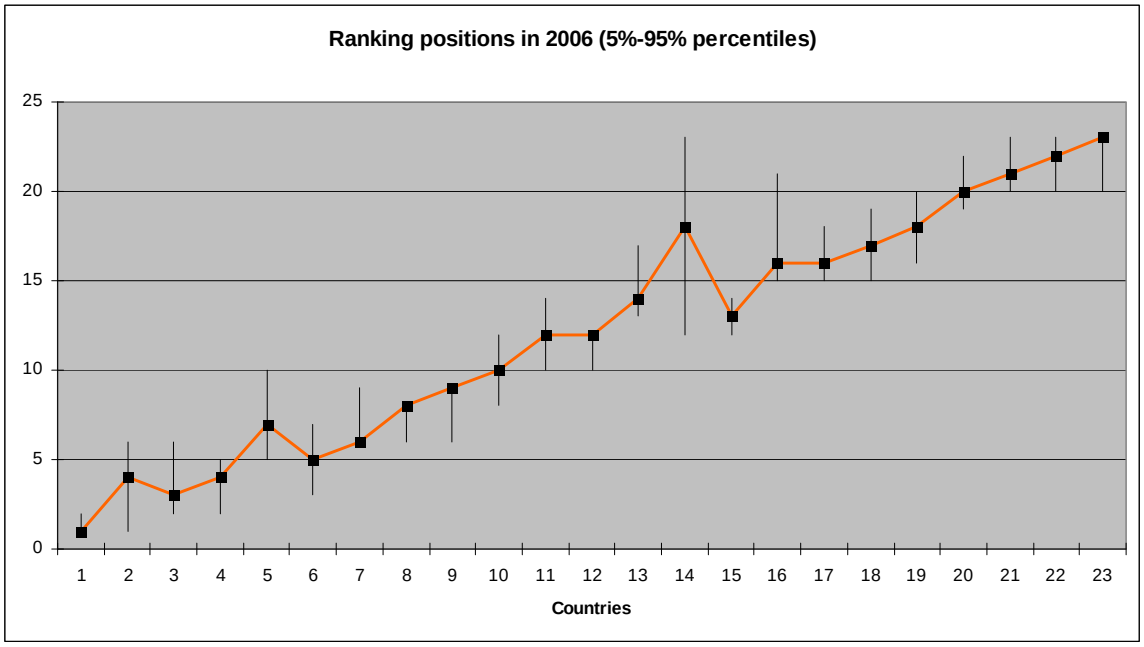


Figure 7 – Results of the Uncertainty Analysis: Ranking Position in 2006 (5%-95% percentiles)

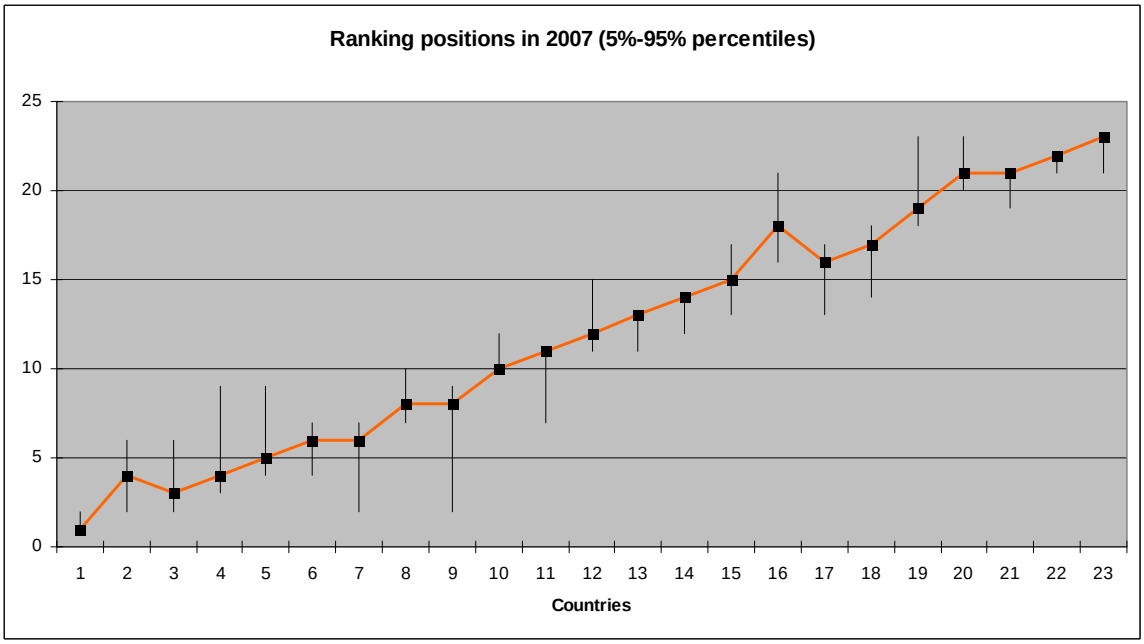


Figure 8 – Results of the Uncertainty Analysis: Ranking Position in 2007 (5%-95% percentiles)

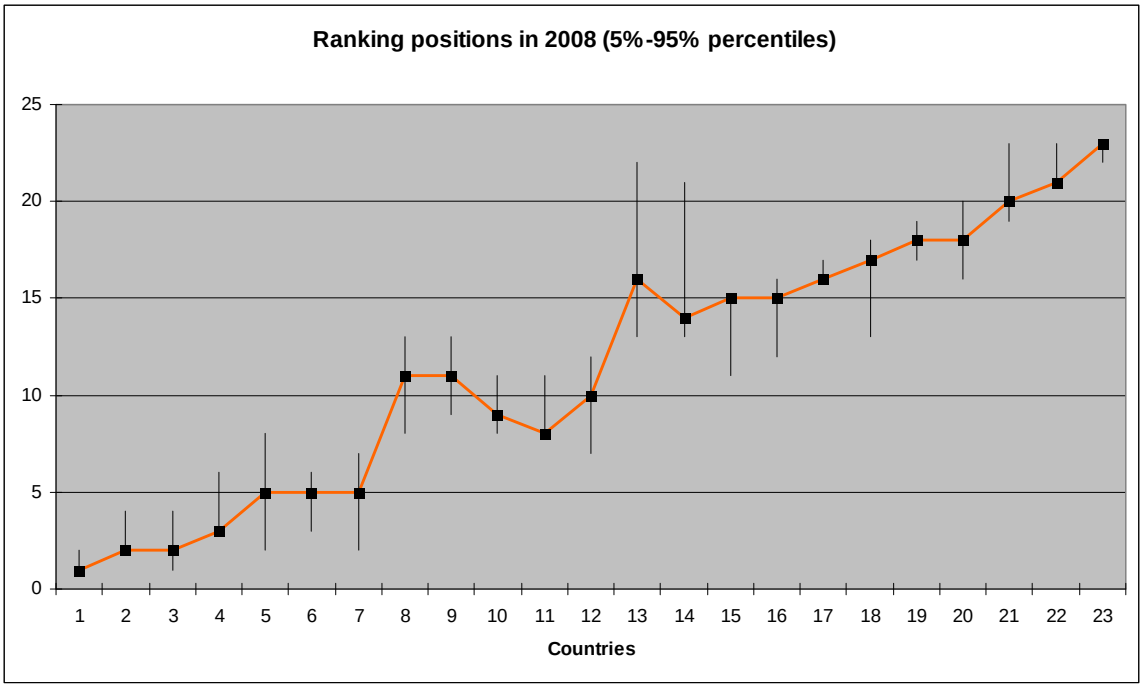


Figure 10 – Results of the Uncertainty Analysis: Ranking Position in 2008 (5%-95% percentiles)

2005	PT	EL	PL	FR	FI	NL	SI	ES	BE	BG	IT	UK	LT	DK	SK	AT	DE	LU	EE	SE	CZ	HU	IE
median	1	3	2	5	3	6	8	6	8	10	10	12	13	14	15	15	17	19	18	21	21	20	23
rank	1	2	3	4	5	6	8	8	9	10	11	12	13	14	15	15	17	18	19	20	22	22	23

Table 19 – Comparison of median values and FCA composite indicator ranking in 2005

2006	FI	PT	DK	SI	NL	PL	FR	UK	IT	LT	EL	AT	LU	IE	BE	BG	SK	ES	SE	EE	CZ	HU	DE
median	1	4	3	4	7	5	6	8	9	10	12	12	14	18	13	16	16	17	18	20	21	22	23
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Table 20 – Comparison of median values and FCA composite indicator ranking in 2006

2007	FI	DK	NL	PT	SI	FR	PL	UK	AT	EL	IT	IE	BE	LT	BG	LU	SE	ES	SK	EE	DE	HU	CZ
median	1	4	3	4	5	6	6	8	8	10	11	12	13	14	15	18	16	17	19	21	21	22	23
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Table 21 – Comparison of median values and FCA composite indicator ranking in 2007

2008	FI	DK	NL	PT	SI	FR	PL	UK	AT	EL	IT	IE	BE	LT	BG	LU	SE	ES	SK	EE	DE	HU	CZ
median	1	2	2	3	5	5	5	11	11	9	8	10	16	14	15	15	16	17	18	18	20	21	23
rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Table 22 – Comparison of median values and FCA composite indicator ranking in 2008

Page 1 ----> Page nnnn

European Commission

EUR 24330 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen
Title: Towards a set of composite indicators on Flexicurity: the Indicator on Flexible and Reliable Contractual Arrangement
Author(s): Anna Rita Manca, Matteo Governatori and Massimiliano Mascherini
Luxembourg: Publication Office of the European Union
2010 – 76 pp. – 21 x 29.70 cm
EUR – Scientific and Technical Research series – ISSN 1018-5593
ISBN 978-92-79-15592-5
DOI 10.2788/84920

Abstract
As a fourth and last step in the process of construction of a set of composite indicators on flexicurity within a joint DG EMPL-JRC project, this paper presents a composite indicator on Flexible and Reliable Contractual Arrangements (FCA), i.e. one of the four dimensions of flexicurity identified by the Commission (see COM(2007) 359). The indicator is based on 19 basic indicators and three sub-dimensions, i.e. i) Regulations on dismissals and use of flexible contractual forms - external flexibility; ii) Flexibility of working time - internal flexibility; iii) Flexibility of work organisation to help combine work and family responsibilities ¿ work-life balance combination flexibility. The indicator covers a four years period (2005 to 2008). The large set of indicators included, going well beyond the strictness of employment protection legislation whereby labour market flexibility is often measured, makes this exercise broader and more comprehensive than any previous attempt to characterise the flexibility dimension within a holistic attempt to measure flexicurity. All indicators used are based on institutional EU-level data sources. Results point to considerable heterogeneity in FCA across the EU, although Member States are not always grouped across well defined geographical clusters often mentioned in relevant literature (e.g. Southern, Anglo-Saxon etc.). The indicator's country ranking is quite stable over time, in particular in the years 2006-2008, while significant differences can be observed between 2005, on the one hand, and 2006-2008, on the other hand. Uncertainty and sensitivity analyses have been performed in order to test the robustness of the Composite Indicator. Those were based on 12000 different simulated scenarios, generated by considering different options with respect to standardization methods, weighting scheme, aggregation rules and the inclusion/exclusion of basic indicators. Results show that the composite indicator's scores and rankings are overall robust, albeit with some variability mainly due to imputation of missing data and low correlation among basic indicators. On average, ranking variability is higher than in the Life Long Learning and Modern Social Security composite indicators, but lower than in the Active Labour Market Policies one, reflecting the varying presence of missing data.

How to obtain EU publications

Our priced publications are available from EU Bookshop (http://bookshop.europa.eu), where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents. You can obtain their contact details by sending a fax to (352) 29 29-42758.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

LB-NA-24330-EN-C